CHAPTER 2 ALTERNATIVES

This is a programmatic effort for creating a coastal restoration program that addresses the ecological and human restoration needs of coastal Louisiana. Conceptual programmatic restoration opportunities (alternatives) were developed to address the critical ecological and human needs criteria identified through the scoping process and other forums. This chapter includes presentation of planning constraints, plan formulation rationale, alternative formulation phases, comparison of the potential impacts for each restoration feature, the recommended LCA Plan, and plan implementation. Detailed discussions of the plan formulation phases are contained in the Main Report. For the sake of clarity, the following sections reiterate some of the information contained in the Main Report about the plan formulation phases. A detailed listing of coast wide plans and corresponding features is presented.

GENERAL

In order to ensure that sound decisions are made with respect to development of alternatives and ultimately plan selection, the plan formulation process requires a systematic and repeatable approach. The Economic and Environmental Principles and Guidelines for Water and Related Land Implementation Studies (P&G) describes the USACE study process and requirements and provides guidance for the systematic development of alternative plans that contribute to the Federal objective. Alternatives should be formulated in consideration of four criteria: completeness, effectiveness, efficiency, and acceptability.

Completeness is the extent to which a given alternative plan provides and accounts for all necessary investments or other actions to ensure the realization of the planned effects.

Effectiveness is the extent to which an alternative plan alleviates the specified problems and achieves the specified opportunities.

Efficiency is the extent to which an alternative plan is the most cost-effective means of alleviating the specified problems and realizing the specified opportunities, consistent with protecting the Nation's environment.

Acceptability is the workability and viability of the alternative plan with respect to acceptance by state and local entities and the public and compatibility with existing laws, regulations, and public policies.

The first phase of the plan formulation process is the initial problem identification. The second phase is a thorough evaluation of the resources within the study area and an assessment of what currently exists within the area compared to estimates of the change in those resources over time. This evaluation, or inventorying phase, accounts for the level or amount of a particular resource that currently exists within the study, i.e., the "Existing Conditions." The phase also involves forecasting to predict what change(s) will occur to resources throughout the period of analysis, assuming no actions are taken to address the problems of marsh/land loss in Coastal Louisiana, i.e. the "Future Without-Project Conditions." Comparison of these two conditions of the study area measures the "Problems" resulting from the change in resources over time and identifies the

"Needs" that must addressed as a result of the problems. Study area "Problems" and resulting "Needs" should be quantified based on this predicted change in resources. This second phase also results in the delineation of "Opportunities" that fully or partially address the "Problems and Needs" of the study area. An "Opportunity" is a resource, action, or policy that, if acted upon, may alter the conditions related to an identified problem. An example "Opportunity" is the utilization of the river for sediment delivery by diversion or dredge disposal.

The third phase is to then assess potential "Opportunities" to generate alternative solutions. Alternative plans are then formulated across a range of potential scales to demonstrate the relative effectiveness of various approaches at varying scales.

In the fourth phase, after alternative plans are developed, they must be "Evaluated" for their potential results in addressing the specific problems, needs, and objectives of the study. The measure of output is expressed by the difference in amount or effect of a resource between the "Future Without-Project" (No Action) conditions and those predicted to occur with each alternative in place (future with-project conditions). This difference is referred to as the benefits of the alternative. The LCA Study focus was on ecosystem restoration benefits, which are measured in metrics that reflect the area, productivity, and value of wetlands that are rehabilitated, restored, or maintained to the extent practicable.

The plan formulation process continues with the fifth phase, comparison of alternative plans to each other utilizing the benefit outputs and costs of the alternatives. A relationship between costs and varying levels of ecosystem restoration outputs across a full range of scales is compared.

The final phase in the process is selection of the plan that best meets the study objectives and the P&G's four criteria: completeness, effectiveness, efficiency, and acceptability.

Using the six-phase formulation process, the LCA Plan that best meets NER objectives was developed.

2.1 PROGRAMMATIC CONSTRAINTS

The development and evaluation of restoration alternatives within coastal Louisiana was constrained by several factors. Foremost among these factors was the fundamental premise that restoration of deltaic processes would be accomplished in part, through reintroductions of riverine flows, but that natural and historical "channel switching" of the Mississippi River would not be allowed to occur. The availability of freshwater, primarily water transported down the Mississippi River, was considered a planning constraint because minimum levels or water flows are required to maintain navigation, flood control, and public water supply, and limit saltwater intrusion. The availability of sediment for restoration efforts was also considered a planning constraint for this study because there is not an unlimited, easily accessible, and low-cost source for restoration efforts.

Another major category of constraints is the scientific and technological uncertainties inherent in large-scale aquatic ecosystem restoration projects. While many of these were known as the plan formulation process began, others became more evident as the formulation process was completed. A summary of the key scientific uncertainties and technological challenges as they are currently understood, along with proposed strategies to address these uncertainties and challenges, is presented below.

2.1.1 Scientific and Technological Uncertainties

Scientists have documented the importance of the Louisiana coastal area for fish and wildlife habitat (Coalition to Restore Coastal Louisiana 1989; Keithly 1991; Herke 1993; Michot 1993; Olsen and Noble 1976), estuarine productivity (Morris et al., 1990), and ecological sensitivity to human activity (Templet and Meyer-Arendt 1988; McKee and Mendelssohn 1989; Reed 1989). This recognition has resulted in considerable efforts to investigate and understand the complex physical (Morris et al. 1990), chemical (Mendelssohn et al. 1981; Morris 1991), and ecological (Montague et al. 1987) processes that drive the system, providing Louisiana with a rich history of scientific studies. Studies on understanding relationships between different habitats and different aquatic species (Minello and Zimmerman1991) have been conducted due to the importance of the Louisiana coast's support to numerous estuarine dependent fish and its ability to provide important nursery habitat for diverse fish communities. The coastal areas have also been important for wintering waterfowl with several studies conducted to understand relationships between waterfowl use and habitat conditions. Oil and gas exploration and production have prompted numerous studies on subsurface geologic conditions. Additional geologic conditions have been investigated to aid in understanding deltaic processes that have shaped the Louisiana coast (Fisk 1944; Kolb and Van Lopik 1958; Frazier 1967; May 1984; Smith et al. 1986; Penland et al. 1988a, 1988b, 1988c; Dunbar et al. 1994; 1995). Studies on the Atchafalaya River and delta have also contributed to our understanding of deltaic processes (USACE 1951; Fisk 1952; Shlemon 1972). In addition, numerous studies performed in other ecosystems are applicable in understanding the ecology and function of the Louisiana coastal area. The results of these investigations provide considerable understanding of the physical, chemical, and biological processes that formed and sustain the Louisiana coast. The numerous state-sponsored studies generated from CWPPRA have developed basic trend information over the past 14 years. Studies funded by the National Science Foundation and others have aided in an understanding of impacts and have provided recommendations for improved operations for some existing diversion projects.

The LCA Study builds upon the best available science and engineering knowledge, which has resulted in part from the work described above. However, many of the studies conducted in the Louisiana coastal area have been limited in geographic extent or technical scope. Therefore, while previous research efforts have contributed to a strong understanding of the processes affecting the Louisiana coastal area, scientific and technical uncertainties still remain. Additional investigations to further reduce the scientific and technical uncertainties and to enhance the likelihood that restoration projects will successfully meet restoration goals would be necessary during LCA Plan implementation. The use of newer techniques like geospatial technology (e.g., GIS and remote sensing) should be investigated to determine their capabilities in answering areas of uncertainty. It is expected that geospatial technologies will be able to answer many of the uncertainties associated with the LCA Study. The LCA Project Delivery Team (PDT) reviewed annual Adaptive Management reports prepared to assess previously constructed CWPPRA projects. These efforts are an extension of the existing monitoring program used to identify “lessons learned” from the many CWPPRA projects, past and future, and will also serve as a valuable assessment of “what worked” and “why it worked” on projects that have been built long enough to provide useful data. Identification of the reasons why other projects did not meet initial project goals is also essential to reduce uncertainties.

This discussion on scientific and technological uncertainties is intended to illustrate that considerable information has been developed from prior studies, but that data gaps still exist and considerable scientific and engineering uncertainties remain. The PDT recognized the uncertainties and conducted plan formulation and evaluation with this recognition. The discussion that follows details the different broad types of uncertainties, with appropriate actions to resolve them during LCA Plan implementation.

Identification of the reasons why other projects did not meet initial project goals is also essential to reduce uncertainties.

The Main Report presents a more detailed discussion on scientific and technological uncertainties that is intended to illustrate the considerable information that has been developed from prior studies, but that data gaps still exist and considerable scientific and engineering uncertainties remain. There are numerous types of uncertainties that need to be addressed to support and improve LCA Study restoration efforts. Each uncertainty requires a different resolution strategy, based on the effects of the uncertainty on the program, degree of uncertainty, cost of addressing the uncertainty, and importance of reducing the uncertainty. The Main Report also discusses the strategies to resolve the four uncertainty types:

- Type 1 - Uncertainties about physical, chemical, geological, and biological baseline conditions
- Type 2 - Uncertainties about engineering concepts and operational methods
- Type 3 - Uncertainties about ecological processes, analytical tools, and ecosystem response
- Type 4 - Uncertainties associated with socioeconomic/political conditions and responses

2.2 PLAN FORMULATION RATIONALE

2.2.1 Coordination to Complete Plan Formulation

The plan formulation effort was conducted as a coordinated and collaborative effort involving a host of Federal and state agencies, the Louisiana academic community, and experts across the Nation. The broad geographic scope of the Louisiana coastal area and the complexity of aquatic ecosystem restoration efforts in general provided the rationale for convening a number of multi-disciplinary teams to provide technical expertise and expedite review and decision-making within the plan formulation process. The teams generally fell into one of three categories: coordination, project execution, and special. The role of each team is described in the following sections.

2.2.1.1 Coordination Teams

Federal Principals Group - A Federal Principals Group (FPG) was established to provide Washington, D.C. level collaboration among Federal agencies for the LCA Study. The FPG for the LCA Study includes regional representatives from the following:

- U.S. Environmental Protection Agency (USEPA), Headquarters;
- Department of Interior - Fish and Wildlife Service (USFWS);
- Department of Interior - Minerals Management Service (MMS);
- Department of Commerce - National Marine Fisheries Service (NMFS);
- Department of Interior - Geological Service (USGS);
- Department of Agriculture - Natural Resources Conservation Service (NRCS);
- Department of Energy (DOE);
- Department of Transportation - Maritime Administration; and
- Department of Homeland Defense - Federal Emergency Management Agency (FEMA).

Regional Working Group **-** A Regional Working Group (RWG) was formed to support the Washington-level Federal Principal's Group and facilitate regional level collaboration and coordination on the LCA Study. The RWG membership mirrors the composition of the FPG.

Executive Team - An Executive Team was formed to provide executive-level guidance and support for the LCA Study. In addition, the Executive Team worked with the District Engineer on various issues throughout the LCA Study and plan formulation. The Executive Team consisted of the following members:

- District Engineer, New Orleans District, USACE
- Deputy District Engineer for Project management, New Orleans District, USCAE
- Secretary of the Louisiana DNR
- Deputy Secretary of the Louisiana DNR

Governor's Advisory Commission on Coastal Restoration and Conservation - By statute, the State of Louisiana recently established a Governor's Advisory Commission on Coastal Restoration and Conservation. The primary purpose of the Advisory Commission is to advise the governor and state legislature on the overall status and direction of the state's coastal restoration program.

Framework Development Team **-** A Framework Development Team (FDT) was formed to provide a forum for Federal interagency representatives, environmental non-governmental groups (NGOs), and State of Louisiana resource agencies to discuss LCA Study activities and technical issues.

2.2.1.2 Project execution teams

Vertical Team - The Vertical Team (VT) was formed for the purpose of ensuring communication and coordinating activities within the USACE at the district, division, and headquarters levels.

The VT has also provided guidance regarding the level of detail and overall approach for completing the LCA Study.

Project Delivery Team (PDT) - Execution of the LCA Study and PEIS rested primarily with the PDT. The PDT was comprised of professional personnel representing several Federal and state agencies, many of whom were "collocated" at the District office. Member agencies included the District, LDNR, USEPA, NRCS, USGS, USFWS, and NOAA.

The PDT also included researchers affiliated with Louisiana State University (LSU), the University of New Orleans (UNO), Southeastern Louisiana University (SLU), and the University of Louisiana at Lafayette (ULL), as well as various contractors.

The PDT was organized into various teams to support key elements of the planning process. The team organization was as follows:

- Public Outreach Work Group
- Goals and Objectives Work Group
- Numerical Modeling Work Group
- Desktop Modeling and Verification Work Group
- Benefits Protocol Work Group
- Environmental Impact Statement Work Group
- Institute of Water Resources (IWR) Plan Assessment Work Group
- Economics Work Group
- Real Estate Work Group
- Engineering Work Group
- Cultural/Recreational Work Group

2.2.1.3 Special teams

National Technical Review Committee – The District formed a National Technical Review Committee (NTRC) to provide external, independent technical review of the LCA Study. The purpose of the NTRC was to ensure quality and credibility of the results of the planning process. The first seven meetings of the NTRC focused on ongoing review, comment study formulation, and plan development efforts. The NTRC held its eighth meeting to complete the review and provide comments on the LCA Study and plan development on 16–17 August 2004. Members of the NTRC included representatives from academia, the oil and gas industry, the Smithsonian Institution, and the USACE Institute for Water Resources. Each person was selected for their technical expertise in coastal geomorphology, river engineering, wetland ecology, socioeconomics, and planning.

Independent Technical Review Team - In coordination with the USACE Office of the Chief of Engineers Value Engineering Study Team (USACE-OVEST) and the Division, a Value Engineering/Independent Technical Review (VE/ITR) Team was established to perform an independent review of the plan formulation process and to perform an evaluation of the conclusions and recommendations of this report. Members of the VE/ITR included employees from the Jacksonville, Mobile, and Wilmington Districts.

Office of the Chief of Engineers Value Engineering Study Team – USACE-OVEST is a organization of the USACE that optimizes the value of programs/projects/processes by the employment of Value Engineering. The team consists of technically skilled people with a cross section of experience in construction, design, operations and maintenance (O&M), and project management. The team is also augmented with resources from throughout USACE. The VE methodology was applied at an early point in the LCA Study to assure the optimization of the scoping effort and subsequent study investigations. The VE study duration, team composition, and study outputs were adjusted to the LCA Study to produce optimum plan formulation results.

2.2.1 Objectives and Principles for Plan Formulation

In conjunction with the study constraints, two sets of strategic level principles guided the LCA Plan formulation process. The first was the USACE-adopted Environmental Operating Principles (EOPs). The second was the Study Guiding Principles for Plan Formulation (Guiding Principles). While the EOPs direct a general, strategic "way of doing business" for all USACE efforts, the Guiding Principles, developed during the first plan formulation scoping process, provide a "way of doing business" to address system-wide problems, needs, and opportunities associated with the Louisiana coastal area. At the tactical level, specific Planning Objectives were necessary to focus formulation of a plan intended to achieve specific outcomes contributing to the attainment of the overarching goal of reversing the current trend of ecosystem degradation and ultimate loss of function in the Louisiana coastal area (as indicated by points, A, B, and C in **figure 2-1** below). This graph demonstrates that multiple outcomes representing restoration of combined ecosystem functions are possible. The planning objectives further describe the elemental system functions that the PDT viewed as essential to reflecting successful restoration.

2.2.2 Planning Objectives

In an effort to guide plan formulation, two tiers of tactical planning objectives were established - hydrogeomorphic and ecosystem. Concepts and features considered in this study, including freshwater diversions, sediment diversions, dedicated dredging/marsh creation, and barrier island protection, may effectively accomplish these planning objectives.

Hydrogeomorphic Objectives:

1. Establish dynamic salinity gradients that reflect natural cycles of freshwater availability and marine forcing (fluctuation related to normal daily and seasonal tidal action or exchange).
2. Increase sediment input from sources outside estuarine basins, and manage existing sediment resources within estuarine basins, to sustain and rejuvenate existing wetlands and rebuild marsh substrate.
3. Maintain or establish natural landscape features and hydrologic processes that are critical to sustainable ecosystem structure and function.

Ecosystem Objectives**:**

1. Sustain productive and diverse fish and wildlife habitats.
2. Reduce nutrient delivery to the Continental shelf by routing Mississippi River waters through estuarine basins while minimizing potential adverse effects.

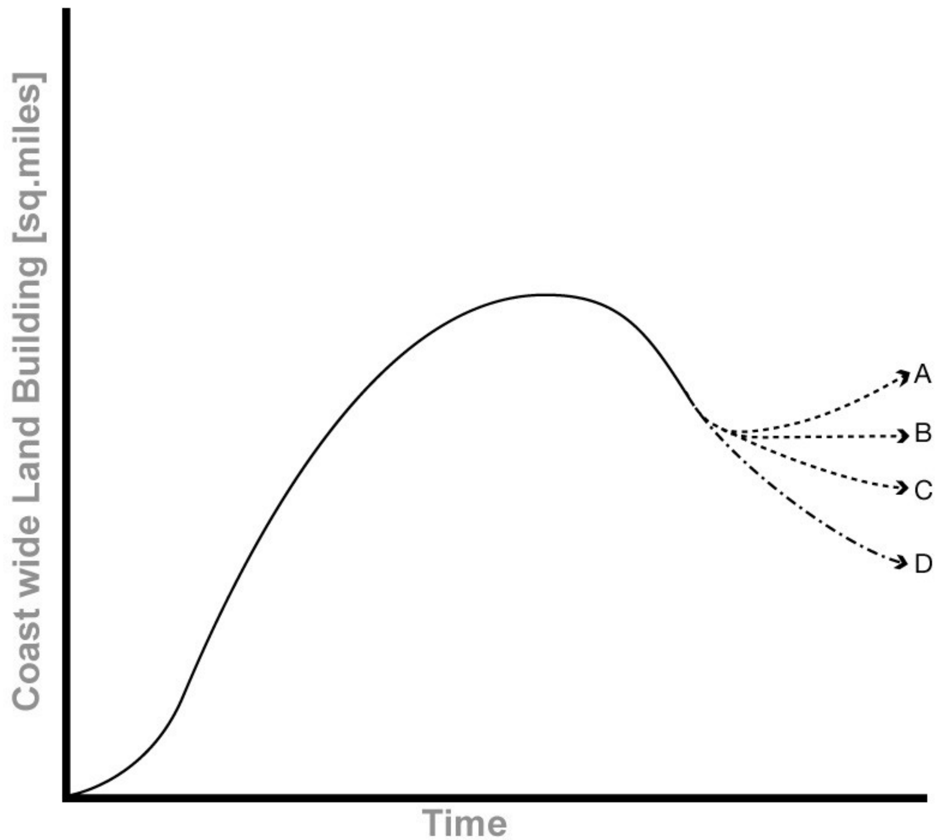


Figure 2-1. Ecosystem Degradation Trend Over Time. *The arrows represent conceptual outcomes for restoration (A, B, C) and the predicted future without-project (D).* ***(Not to scale.)***

2.2.2.1 Environmental operating principles

In 2002, the USACE reaffirmed its long-standing commitment to the environment by formalizing a set of EOPs applicable to decision-making in all programs. The principles are consistent with NEPA; the Department of the Army's Environmental Strategy with its four pillars of prevention, compliance, restoration, and conservation; and other environmental statutes and WRDAs that govern USACE activities. The EOPs have informed the plan formulation process and are integrated into all proposed program and project management processes. The EOPs are:

1. Strive to achieve environmental sustainability, and recognize that an environment maintained in a healthy, diverse, and sustainable condition is necessary to support life.
2. Recognize the interdependence of life and the physical environment, and proactively consider environmental consequences of USACE programs and act accordingly in all appropriate circumstances.
3. Seek balance and synergy among human development activities and natural systems by designing economic and environmental solutions that support and reinforce one another.
4. Continue to accept corporate responsibility and accountability under the law for activities and decisions under our control that impact human health and welfare and the continued viability of natural systems.
5. Seek ways and means to assess and mitigate cumulative impacts to the environment and bring systems approaches to the full life cycle of our processes and work.
6. Build and share an integrated scientific, economic, and social knowledge base that supports a greater understanding of the environment and impacts of our work.
7. Respect the views of individuals and groups interested in USACE activities, listen to them actively, and learn from their perspective in the search to find innovative win-win solutions to the Nation's problems that also protect and enhance the environment.

2.2.2.2 Guiding principles

The PDT compiled the Guiding Principles for Plan Formulation in coordination with key stakeholder groups and with public comments provided during the scoping process.

1. It is evident that management of Louisiana's coast is at a point of decision. Only a concerted effort now will stem this on-going degradation, and thus alternatives must include features which can be implemented in the near-term and provide some immediate benefits to the ecosystem, as well as those which require further development and refinement of techniques and approaches.
2. Appreciation of the natural dynamism of the coastal system must be integral to planning and the selection of preferred alternatives. This should include assessing the risks associated with tropical storms, river floods, and droughts.
3. Alternatives that mimic natural processes and rely on natural cycles and processes for their operation and maintenance will be preferred.
4. Limited sediment availability is one of the constraints on system rehabilitation. Therefore, plan elements including mechanical sediment retrieval and placement may be considered where landscape objectives cannot be met using natural processes. Because sediment mining can contribute to ecosystem degradation in the source area, such alternatives should, to the extent practicable, maximize use of sediment sources outside the coastal ecosystem (e.g., from the Mississippi River or the Gulf of Mexico).
5. Plans will seek to achieve ecosystem sustainability and diversity while providing interchange and linkages among habitats.
6. Future rising sea levels and other global changes must be acknowledged and incorporated into planning and the selection of preferred alternatives.

7. Displacement and dislocation of resources, infrastructure, and possibly communities may be unavoidable under some scenarios. In the course of restoring a sustainable balance to the coastal ecosystem, sensitivity and fairness must be shown to those whose homes, lands, livelihoods, and ways of life may be adversely affected by the implementation of any selected alternatives. Any restoration-induced impacts will be consistent with NEPA in that actions will be taken to avoid, minimize, rectify, reduce, and then, only if necessary, compensate for project-induced impacts.
8. The rehabilitation of the Louisiana coastal ecosystem will be an ongoing and evolving process. The selected plan should include an effective monitoring and evaluation process that reduces scientific uncertainty, assesses the success of the plan, and supports adaptive management of plan implementation.
9. Recognizing that disturbed and degraded ecosystems can be vulnerable to invasive species, implementation needs to be coordinated with other state and Federal programs addressing such invasions, and project designs will promote conditions conducive to native species by incorporating features, where appropriate, to protect against invasion to the extent possible without diminishing project effectiveness.
10. Net nutrient uptake within the coastal ecosystem is maximized through increased residence time and the development of organic substrates, and thus project design should promote conditions that route riverine waters through estuarine basins and minimize nutrient export to shelf waters.

2.2.5 Planning Objectives

In an effort to guide plan formulation, two tiers of tactical planning objectives were established - hydrogeomorphic and ecosystem. Concepts and features considered in this study, including freshwater diversions, sediment diversions, dedicated dredging/marsh creation, and barrier island protection, may effectively accomplish these planning objectives.

Hydrogeomorphic Objectives:

1. Establish dynamic salinity gradients that reflect natural cycles of freshwater availability and marine forcing (fluctuation related to normal daily and seasonal tidal action or exchange).
2. Increase sediment input from sources outside estuarine basins, and manage existing sediment resources within estuarine basins, to sustain and rejuvenate existing wetlands and rebuild marsh substrate.
3. Maintain or establish natural landscape features and hydrologic processes that are critical to sustainable ecosystem structure and function.

Ecosystem Objectives**:**

1. Sustain productive and diverse fish and wildlife habitats.
2. Reduce nutrient delivery to the Continental shelf by routing Mississippi River waters through estuarine basins while minimizing potential adverse effects.

2.3 PLAN FORMULATION

This section summarizes the six phases of plan formulation. Each phase of the plan formulation process provided distinct results that were then used to initiate the next phase. A more detailed description of the entire plan formulation effort is available at the District upon request.

The LCA Study planning process used by the PDT evolved over two years, ultimately resulting in selection of a recommended near-term course of action. During this time, the PDT used an iterative planning process to identify and evaluate the merits of individual restoration features, the effects of combining these features into different coast wide frameworks, and ultimately the ability of these frameworks to address the most critical needs. **Table 2-1** highlights the purpose, decision criteria, and results of the major iterations.

Near the completion of the fifth phase of the plan formulation effort on going review of the study effort by the Vertical Team and PDT identified specific long-range uncertainties regarding the dynamic nature of the coastal ecosystem, science and technology (S&T) for implementation and model predictive capability. The Vertical Team and PDT, with guidance in the form of the Fiscal Year 2005 Federal budget, redirected the plan formulation effort towards the identification of a plan that focused on the critical restoration needs in the near-term, the next 5 to 10 years, along with investigative initiatives to provide better certainty on appropriate long-range restoration needs and activities. The PDT determined that an LCA Plan would best meet the overall study objectives through inclusion of several complementary plan components that differ in scale and time.

2.3.1 Phase I - Establish Planning Objectives and Planning Scales

In Phase I, the PDT developed the tactical Study Planning Objectives and planning scales for the study. The Planning Objectives were developed based on professional knowledge and extensive experience in coastal Louisiana restoration. The PDT also created planning scales to facilitate the development of different alternatives to meet the planning objectives. For the purposes of this report, the term "scale" does not refer to a specific state of the landscape. Rather, it reflects the degree to which fundamental environmental processes would be restored or reestablished, and the resulting ecosystem and landscape changes that would be expected over the next 50 years. The planning scales were developed in consideration of the tactical planning objectives and the strategic principles and established a minimum range of alternative restoration output necessary for plan formulation in each subprovince.

The PDT determined that the highest, most ambitious scale would be an annual net increase in ecosystem function. This uppermost scale, affecting an approximate 50 percent increase over no net loss, is referred to as "*Increase.*" The PDT determined that no net loss of ecosystem function would be an appropriate intermediate scale. This scale is referred to as "*Maintain.*" Reducing the projected rate of loss of function was judged to be another appropriate intermediate scale, as it is sufficiently different from the other scales and would offer an option that could provide substantial benefits over no action. This scale, achieving an approximate 50 percent reduction in the current loss rate, is referred to as "*Reduce.*" The lowest possible scale was no further action above and beyond existing projects and programs, such as CWPPRA. This scale was the basis for the No Action Alternative.

Table 2-1. Major Iterations of Plan Formulation.

	Iteration We started with:	**Purpose** Our intent was to:	**Criteria** We made decisions based on:	**Result** The iteration ended with:
Phase 1	EOPs and Guiding Principles	Develop Planning Objectives and Planning Scales	• Professional judgment • Extensive CWPPRA experience • Scoping Comments	Planning Objectives Planning Scales
Phase 2	Coast 2050 Plan Section 905(b) Report	Assess broad scale strategies in 2050 Plan to identify Core Strategies for LCA Study effort	• Existing resources available in each of the four Subprovinces	LCA Core Strategies
Phase 3	LCA Core Strategies	Develop restoration features that would support LCA Core Strategies	• Planning Objectives • Creating features that would meet various Planning Scales • Developing features for all LCA Core Strategies	Restoration Features
Phase 4	Restoration Features	Combine Restoration Features into Subprovince Alternative Frameworks	• Need to combine Restoration Features into Alternative Frameworks that achieve different Planning Scales • Need to develop significantly different Restoration Features for all LCA Core Strategies	Subprovince Frameworks
	Subprovince Frameworks	Create, assess, and select Coast Wide Restoration Frameworks	• Cost effectiveness (CE) • Incremental Cost Analysis (ICA)	Tentative Final Array of Coast Wide Restoration Frameworks
Phase 5	Tentative Final Array of Coast Wide Restoration Frameworks	Address completeness of Coast Wide Restoration Frameworks in Tentative Final Array	• Public meeting and stakeholder comments • Re-verification of CE/ICA	Final Array
Phase 6	Final Array	Identify highly cost-effective Restoration Features within the Final Array that address most critical needs	• Critical need sorting criteria • Critical need assessment criteria	LCA Plan

2.3.2 Phase II - Assess Restoration Strategies from the Coast 2050 Plan

The PDT, in conjunction with the Vertical Team and FDT, reviewed the Coast 2050 Plan and the LCA Section 905(b) reconnaissance report (for which the Coast 2050 Plan was the basis). These plans are described in Attachment 2, Prior Studies, Reports and Existing Water Projects. These reports identified problems in both the current and future coastal landscape and laid out 93 broad-scale strategies for addressing ecosystem restoration. Strategies in the context of the

Coast 2050 and 905(b) reports often translate directly to restoration projects. However, since many of the 93 strategies in these documents represented common restoration methods, the strategies captured for incorporation in the LCA plan formulation effort represent those most common or "core" restoration methodologies identified both coast wide and in each subprovince.

Overall, the strategies would describe methods to accomplish:

- Creation and sustenance of wetlands through input and accumulation of sediment;
- Maintenance of estuarine and wetland salinity gradients for habitat diversity; and
- Maintenance of ecosystem linkages for the exchange of organisms and system energy.

Because these accomplishments were very similar to the tactical planning objectives developed in Phase I, the PDT assessed the 93 broad-scale strategies to determine common methodologies for effecting restoration of wetland and system functions. As part of this study, the PDT identified a smaller subset of core strategies for coastal restoration efforts in the four subprovinces.

For Subprovince 1, the core restoration strategies included basin-wide freshwater reintroduction and salinity control. Reintroductions were selected because of the readily available freshwater resource, the Mississippi River. Because of its function as a conveyance of saline water into the central portion of the subprovince, the closure or constriction of the existing MRGO navigation project was identified as a potentially major component of the salinity control strategy.

For Subprovince 2, the core restoration strategies included: sustaining barrier islands, headlands, and shorelines; managing the available sediment of the Mississippi River; freshwater introduction; Mississippi River water and sediment introduction via the formation of a new delta; and preserving land bridges within the Barataria Basin.

For Subprovince 3, the core restoration strategies included: restoring Terrebonne / Timbalier barrier islands; rebuilding land in eastern Terrebonne Basin; modifying the Old River Control Complex operation scheme to increase sediment input to the Atchafalaya River; Mississippi River water and sediment introduction via the formation of a new delta; and management of Atchafalaya River freshwater, sediment, and nutrients.

In the Chenier Plain (Subprovince 4), there are no excess riverine resources available to promote land building and to control salinities in the estuarine system. As such, the core strategy for this subprovince is the control of estuarine salinities through the management of rainfall and runoff inputs to the system and the management of existing hydrologic structures and geomorphic features.

2.3.3 Phase III - Develop and Evaluate Restoration Features

In Phase III, the PDT developed 166 potential restoration features that would support the restoration strategies identified for each of the subprovinces in Phase II and that would achieve some level of the planning scales identified in Phase I. The term feature is used to describe any specific restoration project or defined collection of structural and non-structural elements combined to affect a wetland restoration action. Features represent the specific solutions for which costs were developed and from which restoration plans, or "frameworks", would be created. The term framework will be used to describe an assemblage of features developed to produce a discreet, cohesive, logical plan for achieving systemic restoration within a definable hydrologic or ecologic area.

The intent of this effort was to provide an initial identification of the most effective frameworks for meeting the overarching study objectives in concert with key strategies in each subprovince. Within this context, in addition to the programmatic nature of the NEPA documentation, the potential restoration features are intended to be representative of the most promising restoration actions and plan combinations for planning purposes. These features provide a basis for estimating costs and potential benefits and provide a starting point for identifying the most efficient framework combinations, most effective steps for addressing critical ecosystem needs, and estimating the overall cost of the ultimate implementation effort. The final refinement of feature scale and location is intended to be addressed in decision documents subsequent to the approval of this report. In developing the restoration features, the PDT took advantage of the extensive experience gained from other coastal restoration efforts, such as CWPPRA.

Preliminary costs and estimates regarding the potential for each feature to modify ecosystem functioning were based on experience and insight gained through the execution of the CWPPRA program, along with professional judgment and the best available information. The fourteen years of effort in project development and design under the CWPPRA program, along with design work completed under other Federal and state programs, provided an extensive base of design information to build on with basic component costs developed in the CWPPRA Engineer Work Group. Detailed documentation of the design assumptions, feature level of detail, and the development of the cost estimates are available at the District. The result of this phase was a "tool box" of restoration features for each subprovince, including features that addressed freshwater reintroduction (diversion), sediment diversion, hydrologic restoration, hydrologic modification, land acquisition, interior shoreline protection, barrier island and barrier headland restoration, and marsh creation and restoration. **Table 2-2** lists the number of features for each subprovince and categorizes them by feature type.

In addition, the PDT developed features whose implementation would result in varying levels of ecosystem function restoration. This exercise provided the PDT with similar features in some of the subprovinces, particularly in Subprovinces 1 and 2, that would address the reduce, maintain, and increase planning scales. For example, of the 21 freshwater reintroduction features identified for Subprovince 1, the PDT developed small, medium, and large freshwater diversion features to influence the same geographic area. Each of the diversions would result in a different level of ecosystem function restoration, and thus each would be more or less appropriate to satisfy a particular planning scale (i.e., a small freshwater diversion may or may not achieve the "increase" planning scale, whereas a large freshwater diversion in the same area would be more likely to achieve the "increase" scale).

The composition of restoration features (e.g., beneficial use of dredged materials, sediment diversion, etc.) developed for each subprovince was largely guided by the need to implement the restoration strategies previously identified in Phase II. For example, in Subprovinces 1 and 2, freshwater reintroduction was a restoration strategy. As such, the composition of restoration features for those subprovinces weighs heavily in favor of freshwater reintroductions because of the presence of an available resource, the Mississippi River. Careful examination of the distribution of restoration features developed in each subprovince can identify the nature of the ecosystem function in the area. Areas with or adjacent to abundant freshwater resources present ample diversion opportunities (i.e., Deltaic Plain) while areas with limited riverine resources (i.e., Chenier Plain) tend to provide more focus on preservation and management.

Table 2-2. Types of Restoration Features by Subprovince.

Restoration Feature	Subprovince 1	Subprovince 2	Subprovince 3	Subprovince 4
Freshwater Reintroduction (Diversion)	21	30	1	
Sediment Diversion	21	18	1	
Dedicated Dredging and Beneficial Use / Marsh Creation and Restoration	12	4	1	1
Salinity Control	1		2	16
Structure Modification (Hydrologic Restoration)	4	1		
Hydrologic Modification (Hydrologic Restoration)	1		12	4
Land Acquisition	1			
Barrier Island, Barrier Headland, and Interior Shoreline Protection and Restoration	1	1	10	2
Subprovince Totals	62	54	27	23
Total Number of Restoration Features for All Subprovinces	166			

As a final step in Phase III, the PDT made initial assessments of the positive, negative, or neutral fit of the features to address the planning objectives established for the study. This positive, negative, or neutral assessment was also made for each feature against a broad range of resources. These assessments were used to identify strengths and weaknesses of features and as a basis for including them in appropriate subprovince frameworks in Phase IV.

2.3.4 Phase IV - Develop and Evaluate Subprovince Frameworks

2.3.4.1 Development of subprovince frameworks

In Phase IV, the PDT created multiple frameworks, for each subprovince. It then evaluated the outputs and benefits of each subprovince framework using hydrodynamic and ecological models and benefit assessment protocols described in this section.

Since the resolution level and other capabilities of the available hydrodynamic and ecologic modeling system precluded adequate assessments of the effects of individual features in discreet increments, the analysis focused on combinations of features. This approach provided a basis for identifying the features that are the most likely to be effective and therefore should be included in the LCA ecosystem restoration plan. More detailed evaluations of individual features can be performed to support decisions to implement each of the features.

The combinations of restoration features in subprovince frameworks were guided by two requirements: 1) the need to combine restoration features to achieve various levels of planning scales in the subprovince, and 2) the need to develop appreciably different frameworks in each subprovince that would provide alternative planning approaches.

The PDT accomplished the second requirement with the use of restoration "approaches" that it created for each subprovince. By using different approaches to achieving restoration inside a subprovince, the PDT was able to develop appreciably different combinations of restoration features, and, in turn, an appreciably different set of frameworks. . For example, in Subprovince 1, the PDT identified "minimize salinity change" and "continuous [freshwater] reintroduction" as two different restoration approaches. The mix of restoration features in a framework to accomplish the "minimize salinity change" restoration approach would likely be one with few freshwater reintroduction features and/or where freshwater reintroduction features would be relatively small to medium. On the other hand, a mix of restoration features in a framework to accomplish the "continuous [freshwater] reintroduction" restoration approach would likely be one that relied heavily on freshwater reintroduction features, including features that would be relatively large. Restoration approaches for each subprovince are listed below:

Subprovinces 1 and 2

- Minimize Salinity Changes
- Continuous Reintroduction (w/Stage Variation)
- Mimic Historic Hydrology

Subprovince 3

- Rehabilitation/maintenance of geomorphic features
- Land Building by Delta Development
- Maximize Mississippi and Atchafalaya Flows

Subprovince 4

- Large-scale Salinity Control
- Perimeter Salinity Control
- Freshwater Introduction Salinity Control

To prevent the analysis of alternative frameworks from becoming overly complex, a maximum of nine frameworks were developed for each subprovince, with three frameworks for each planning scale (increase, maintain, and reduce). Around each planning scale a framework was developed based on the restoration approaches for that sub-province. Subprovince 1, for example, contained 3 frameworks designed to increase ecosystem function based on minimizing salinity changes (E1), continuous reintroduction of freshwater (E2), and mimicking historic hydrology (E3). Of the 166 available restoration features in the toolbox, only 111 were found necessary to meet the criteria stated above in formulating the subprovince frameworks.

During Phase V of plan formulation, the PDT developed a reasonable, "supplemental" framework for each subprovince, the process and rationale of which is presented in the Phase V summary. To ensure that this Phase IV summary identifies all subprovince frameworks that were evaluated in this study, the supplemental framework for each subprovince is included in the total count of subprovince frameworks, described below. A total of 32 subprovince frameworks were developed and evaluated in this study in addition to the no-action alternative for each Subprovince. The individual features that make up each subprovince framework are identified in **tables 2-3** through **2-6.** Full detailed descriptions of subprovince frameworks are available upon request through the New Orleans District office.

Subprovince Frameworks
Subprovince 1 = 10 Frameworks
Subprovince 2 = 10 Frameworks
Subprovince 3 = 5 Frameworks
Subprovince 4 = 7 Frameworks

For Subprovince 1, there were a total of ten frameworks: three "reduce" (R); three "maintain" (M); and three "increase" (E); and the supplemental framework (N) (**table 2-3**). For Subprovince 2, there were a total of ten frameworks: three "reduce" (R); three "maintain" (M); three "increase" (E); and the supplemental framework (N) (**table 2-4**). For Subprovince 3, there were a total of five frameworks: three "reduce" (R); one "maintain" (M); and the supplemental framework (N) (**table 2-5**). For Subprovince 4, there were a total of seven frameworks: three "maintain" (M); three "increase" (E); and the supplemental framework (N) (**table 2-6**).

Table 2-3. Subprovince 1 Frameworks.

Restoration Features	R1	R2	R3	M1	M2	M3	E1	E2	E3	N1
15,000 cfs diversion at American/California Bay				x			x	x		
110,000 cfs diversion (div.) at American/California Bay with sediment enrichment			x		x					x
250,000 cfs div. at American/California Bay with sediment enrichment						x			x	
12,000 cfs div. at Bayou Lamoque		x	x		x	x		x	x	x
5,000 cfs div. at Bonnet Carré Spillway	x	x		x						
10,000 cfs div. at Bonnet Carré Spillway						x	x	x	x	
200,000 cfs div. at Caernarvon w/ sediment enrichment								x		
1,000 cfs div. at Convent/Blind River			x			x			x	
5,000 cfs div. at Convent/Blind River		x			x		x			x
10,000 cfs div. at Convent/Blind River								x		
15,000 cfs div. at Fort St. Philip			x	x			x			
26,000 cfs div. at Fort St. Philip w/ sediment enrichment						x				
52,000 cfs div. at Fort St. Philip w/ sediment enrichment									x	
1,000 cfs div. at Hope Canal	x	x	x	x	x	x			x	x
1,000 cfs div at Reserve Relief Canal									x	
6,000 cfs div at White's Ditch							x			
10,000 cfs div. at White's Ditch		x	x		x	x			x	x
Sediment delivery by pipeline at American/California Bays				x			x		x	
Sediment delivery via pipeline at Central Wetlands	x			x			x			
Sediment delivery via pipeline at Fort St. Philip				x			x			
Sediment delivery via pipeline at Golden Triangle							x			
Sediment delivery via pipeline at La Branche	x			x			x			x
Sediment delivery via pipeline at Quarantine Bay	x						x			
Authorized opportunistic use of the Bonnet Carré Spillway										x
Increase Amite River Diversion Canal influence by gapping banks										x
Marsh nourishment on the New Orleans East land bridge										x
Mississippi River Delta Management Study										x
Mississippi River Gulf Outlet Environmental Restoration Features					x		x			x
Modification of operation of the Caernarvon freshwater diversion. (optimize for marsh creation)										x
Rehabilitate Violet Siphon and post authorization for the diversion of water through Inner Harbor Navigation Canal for increased influence into Central Wetlands										x

Note: R = Reduce; M = Maintain; E = Increase; N = Supplemental; Approaches: 1 = Minimize salinity change; 2 = Continuous reintroduction; 3 = Mimic historic hydrology.

Table 2-4. Subprovince 2 Frameworks.

Restoration Features	R1	R2	R3	M1	M2	M3	E1	E2	E3	N1
5,000 cfs diversion (div.) at Bastian Bay/Buras			x							
130,000 cfs div. at Bastian Bay/Buras		x								
120,000 cfs div. near Bayou Lafourche									x	
60,000 cfs div. at Boothville w/ sediment enrichment.										x
1,000 cfs div. at Donaldsonville		x	x		x	x				x
5,000 cfs div. at Donaldsonville w/ sediment enrichment								x		
1,000 cfs div. at Edgard		x	x		x	x				x
5,000 cfs div. at Edgard w/ sediment enrichment	x							x		
5,000 cfs div. at Empire			x							
90,000 cfs div. at Empire								x		
5,000 cfs div. at Fort Jackson			x							
60,000 cfs div. at Fort Jackson	x			x						
60,000 cfs div. at Fort Jackson w/ sediment enrichment						x	x	x		
90,000 cfs div. at Fort Jackson w/ sediment enrichment									x	
150,000 cfs div. at Fort Jackson w/ sediment enrichment					x					
1,000 cfs div. at Lac Des Allemands		x			x	x				x
5,000 cfs div. at Lac Des Allemands w/ sediment enrichment				x			x	x	x	
5,000 cfs div. at Myrtle Grove	x		x	x			x			x
15,000 cfs div. at Myrtle Grove		x								
38,000 cfs div. at Myrtle Grove w/ sediment enrichment					x					
75,000 cfs div. at Myrtle Grove w/ sediment enrichment						x				
150,000 cfs div. at Myrtle Grove w/ sediment enrichment								x		
5,000 cfs div at Oakville			x							
1,000 cfs div. at Pikes Peak		x	x		x	x				x
5,000 cfs div. at Pikes Peak w/ sediment enrichment								x		
5,000 cfs div. at Port Sulphur			x							
Barataria Basin barrier shoreline restoration	x	x	x	x	x	x	x	x	x	x
Implement the LCA Barataria Basin Wetland Creation and Restoration Study	x			x			x		x	x
Mississippi River Delta Management Study							x		x	x
Modification of operation of Davis Pond diversion										x
Sediment delivery via pipeline at Bastian Bay				x			x			
Sediment delivery via pipeline at Empire			x	x			x			
Sediment delivery via pipeline at Head of Passes				x			x			
Sediment delivery via pipeline at Myrtle Grove	x			x			x			x
Third Delta (120,000 cfs diversion)										x

Note: R = Reduce; M = Maintain; E = Increase; N = Supplemental; Approaches: 1 = Minimize salinity change; 2 = Continuous reintroduction; 3 = Mimic historic hydrology.

Table 2-5. Subprovince 3 Frameworks.

Restoration Features	**R1**	**R2**	**R3**	**M1**						**N1**
Backfill pipeline canals			x	x						
Bayou Lafourche 1,000 cfs pump	x	x		x						x
Convey Atchafalaya River water to northern Terrebonne marshes	x		x	x						x
Freshwater introduction south of Lake De Cade	x	x		x						
Freshwater introduction via Blue Hammock Bayou	x	x		x						x
Increase sediment transport down Wax Lake Outlet	x	x		x						x
Maintain land bridge between Bayous du Large and Grand Caillou	x		x	x						x
Maintain land bridge between Caillou Lake and Gulf of Mexico.			x	x						x
Maintain northern shore of East Cote Blanche Bay at Pt. Marone			x	x						x
Maintain Timbalier land bridge			x	x						
Multipurpose operation of the Houma Navigation Canal (HNC) Lock.	x	x	x	x						x
Optimize flows and Atchafalaya River influence in Penchant Basin	x	x	x	x						x
Rebuild historic reefs –Rebuild historic barrier between Point Au Fer and Eugene Island	x	x	x	x						
Rebuild historic reefs – Construct segmented reef/breakwater/jetty along the historic Point Au Fer barrier reef from Eugene Island extending towards Marsh Island to the west	x	x	x	x						
Acadiana Bays Estuarine Restoration			x	x						x
Rehabilitate northern shorelines of Terrebonne/Timbalier Bays			x	x						
Relocate the Atchafalaya navigation channel	x	x		x						x
Restore Terrebonne barrier islands.			x	x						x
Stabilize banks of Southwest Pass			x	x						
Stabilize gulf shoreline of Point Au Fer Island			x	x						x
Alternative operational schemes of the Old River Control Structure (ORCS) operational scheme	x	x		x						x
Third Delta (120,000 cfs diversion)		x		x						

Note: R = Reduce; M = Maintain; N = Supplemental; Approaches: 1 = Rehabilitation/maintenance of geomorphic features; 2 = Land-building by delta development; 3 = Maximize Mississippi and Atchafalaya flows.

Table 2-6. Subprovince 4 Frameworks.

Restoration Features				M1	M2	M3	E1	E2	E3	N1
Black Bayou bypass culverts										x
Calcasieu Pass lock				x			x			
Calcasieu Ship Channel beneficial use				x	x	x	x	x	x	x
Chenier Plain freshwater and sediment management and allocation reassessment.										x
Dedicated dredging for marsh restoration					x	x		x	x	
East Sabine Lake hydrologic restoration					x			x		x
Freshwater introduction at Highway 82				x	x	x	x	x	x	x
Freshwater introduction at Little Pecan Bayou				x	x	x	x	x	x	x
Freshwater introduction at Pecan Island				x	x	x	x	x	x	x
Freshwater introduction at Rollover Bayou				x	x	x	x	x	x	x
Freshwater introduction at South Grand Chenier				x	x	x	x	x	x	x
Freshwater introduction via Calcasieu lock and Black Bayou culverts						x			x	
Gulf shoreline stabilization					x		x	x	x	x
Modify existing Cameron-Creole watershed control structures					x			x		x
New lock at the GIWW					x			x		
Sabine Pass lock				x			x			
Salinity control at Alkali Ditch					x			x		x
Salinity control at Black Bayou					x			x		x
Salinity control at Black Lake Bayou					x			x		x
Salinity control at Highway 82 Causeway					x	x		x	x	x
Salinity control at Long Point Bayou.					x			x		x
Salinity control at Oyster Bayou					x			x		x

Note: M = Maintain; E = Increase; N = Supplemental; Approaches: 1 = Large-scale salinity control; 2 = Perimeter salinity control; 3 = Freshwater introduction salinity control.

2.3.4.2 Evaluation of subprovince frameworks

The four subprovinces in the LCA represent the appropriate area for evaluating and comparing specific hydrodynamic and ecologic functions. In order to evaluate the outputs and benefits of a particular subprovince framework, the PDT employed hydrodynamic and ecological models, benefit protocols, and agency and academic expertise to generate baseline information about the effects of the combinations of restoration features. Outputs and benefits evaluated by the PDT included measures of ecosystem function and response such as: land building, habitat switching, primary productivity of land and water, removal of nitrogen from Mississippi River water; and habitat use of wetlands by 12 coastal species. The outputs/benefits covered an array of ecosystem attributes and functions, and they provided a means of comparing complex patterns, both in space and time, of ecosystem change. All benefits were expressed relative to the No Action Alternative. A detailed description of the use of hydrodynamic and ecologic models, as well as the benefit protocols, to evaluate subprovince frameworks can be found in appendix C HYDRODYNAMIC AND ECOLOGICAL MODELING.

Land Building - This benefit assessment protocol measured the achievement of the subprovince framework in creating and preserving land (e.g., wetlands, barrier islands, and ridges) after 50 years. The measurement for land building was expressed in acres.

Habitat Switching - This benefit assessment protocol measured ecosystem response after 50 years by determining the conversion of wetland habitats from one type into another type, including open water. For example, freshwater reintroductions in a subprovince may result in the wetland habitat composition for the subprovince to switch to a composition where there was a greater percentage of freshwater marsh after 50 years. The measurement for habitat switching was expressed as change of habitat type in acres.

Primary Productivity of Land and Water - This benefit assessment protocol measured the change in primary productivity of land and water after 50 years. The PDT used the results from this benefit protocol and the Habitat Use benefit protocol, described below, to gauge the quality of the wetland habitats after 50 years. The measurement for primary productivity of land and water was expressed in terms of an index of composite plant productivity across the range of habitat types in the system.

Removal of Nitrogen from the Mississippi River - This benefit assessment protocol assessed the amount of nitrogen removed from the Mississippi River by the subprovince framework in tons per year. This assessment provided the PDT with information on how well a particular subprovince alternative would help address the hypoxia problem in the gulf. The measurement for removal of Nitrogen from the Mississippi River was expressed as a percentage of nutrients removed.

Habitat Use - This benefit assessment protocol measured the fish and wildlife habitat value for each marsh habitat type after 50 years. The PDT assessed habitat use for 12 coastal species, including: white shrimp, brown shrimp, oyster, gulf menhaden, spotted seatrout, Atlantic croaker, largemouth bass, American alligator, muskrat, mink, otter, and dabbling ducks. The 12 species were chosen because they provide the best representation of the ecologically diverse productivity of the coastal system. This assessment provided the PDT with information on the relative abundance of preferred habitats for the 12 coastal species in response to implementation of a subprovince framework. The measurement for habitat use was expressed in habitat units (HU).

The benefits were calculated for each of the subprovince frameworks and the end result was costs and benefits associated with each framework.

2.3.5 Phase V - Select a Final Array of Coast Wide Frameworks that Bests Meets the Planning Objectives

The subprovince frameworks developed by the PDT and evaluated through the ecologic models provided the basis for developing larger coast wide restoration frameworks. The creation of these coast wide frameworks was based on identifying the optimal combinations of the subprovince frameworks. Due to the fact that Subprovinces 1 through 3 share many of the same restoration resources, the PDT determined that these subprovince frameworks would need to be combined in a manner that determine the best allocation of resources while achieving the largest environmental benefits. Within the Deltaic Plain (Subprovinces 1 to 3), the availability of river water and sediment served to limit the number of possible combinations. There were no such limiting factors for the Chenier Plain, therefore any of the Subprovince 4 frameworks could be combined with any combination of the Subprovinces 1 to 3 frameworks. In addition a key difference in basic system function between the deltaic and Chenier Plains required that different benefit metrics be used. This allowed some simplification of the coast wide framework development process since the Subprovince 4 frameworks could be independently optimized. Therefore, combinations of frameworks in Subprovinces 1 to 3 were developed independently from the Chenier Plain frameworks.

The PDT used the IWR-Plan computer program (Version 3.3, USACE) to create and compare coast wide frameworks, which were composed of a framework from each subprovince. This automated program grouped the 32 subprovince frameworks and no-action alternatives into thousands of different combinations. The program then performed a cost effectiveness and incremental cost analysis (CE/ICA) using the outputs/benefits and the estimated costs that had been previously developed in the initial plan formulation phases.

2.3.5.1 Cost effectiveness/incremental cost analysis

The Study developed and evaluated alternative coast wide frameworks formulated to preserve coastal habitat and functions. The benefits of the various frameworks were defined in non-monetary units, as previously described. Benefits for most of the study area were evaluated using a qualitative and quantitative metric that assessed each alternative's contribution to the stock of natural resources. In the Chenier Plain portion of the study area, benefits were measured more simply in acres of land preserved or restored. Since these feature outputs were not readily translatable to dollar terms, traditional monetary benefit-cost analysis could not be performed. Consequently, the use of the CE/ICA method was selected for the comparison of ecologic output benefits versus costs.

In the cost effective analysis, the combined weighted ecologic outputs, provided by the ecologic models and benefit assessment protocols described in the previous section, were documented for each coast wide framework. The combined weighted outputs and costs for each framework were also displayed and ordered by level of benefit. The primary factors of interest were ecological benefit versus cost. Detailed discussion of this portion of the analysis is available upon request through the New Orleans District office.

The coast wide frameworks were then assessed according to their ability to produce benefits for a given cost level. The result was a listing of coast wide frameworks that would achieve each benefit level at the lowest cost. A theoretical line, or an "efficient frontier", was developed to show those restoration frameworks with the lowest cost to benefit ratios. Restated, alternative frameworks screened in this manner met these two criteria: (1) no other solution produces the same level of benefit for less cost, and (2) no other framework provides more benefit for the same or less cost.

The cost-effectiveness assessment and identification of the efficient frontier was followed by an incremental cost analysis. Incremental cost is the additional cost for each increase in the level of output. Changes in incremental costs, combined with other selection criteria discussed below, facilitated a process of evaluating the desirability of implementing the remaining plans in the absence of a strict guideline for determining the best outcome (such as maximizing net benefits, as is done in NED analysis

2.3.5.2 Development of the tentative final array for the Deltaic Plain

Following an initial CE/ICA analysis, the alternative framework selection process continued by applying three additional criteria to cost-effective coast wide frameworks. These criteria were developed to aid in identifying the point along the efficient frontier where coast wide frameworks could be anticipated to produce broad enough systemic benefits as to provide qualitative certainty of completeness. The three criteria were:

1. Alternative frameworks were limited to those that reduced land loss by at least one half of the current rate (based on 1990 to 2000 land loss data) of -24 mi^2/yr to -10 mi^2/yr. Reducing land loss by this amount would greatly contribute to the reduction of land loss as a result of ongoing restoration efforts.
2. Alternative frameworks were evaluated for their potential to provide storm surge protection across the coast (i.e., in all subprovinces), as well as for their potential to impact the navigation industry.
3. Alternative frameworks were assessed for their potential to add environmentally important features, such as barrier islands or a Third Delta feature, in subsequent implementation phases.

The first criteria simply assured that the frameworks identified would exceed the beneficial level that could be attained through current restoration programs. These programs have been identified as being capable of achieving only a fraction of the necessary restoration outputs. The second criteria sought to assure an adequate distribution of restoration measures by qualitatively identifying the relative damage risk to damage reduction potential. The comparison of spatially fixed investment versus potential wetland restoration effect allowed a qualified judgment of wetland restoration completeness versus relative use. The third criteria simply assessed and assured that important system needs or restoration opportunities were not being systematically overlooked as an artifact of the subprovince framework assemblages.

During this stage of the framework selection process, the PDT evaluated the frameworks that formed the cost-efficient frontier based on the above criteria and eliminated several of the frameworks from further consideration. Some cost-effective frameworks were eliminated because they did not provide comprehensive potential for coast wide restoration. Those cost-effective alternative frameworks that met the criteria occurred at approximately the point in the cost-effective curve at which the cost per unit benefit begins to rise rapidly. The CE/ICA software generates a numbered labeling to specifically identify the analyzed framework combinations these numbers will be used throughout the remainder of the report to refer to the cost effective or tentatively selected coast wide frameworks. Frameworks 5110, 7002, 7410, and 7610 represent those cost effective combinations that define the upper limit of the cost effective frontier. Framework 7002 represented the terminal point of the cost-efficient frontier shown in **figure 2-2**. However, upon review of these frameworks, the PDT identified several environmentally important features that were not included in or addressed by any of the cost-effective frameworks on the curve.

It was determined that additional frameworks near the cost-effective curve, particularly near the point of rapidly increasing unit cost, could fall within the limits of confidence, and as such could be considered in the final array. These additional frameworks would provide more completeness to a final array of restoration solutions. Beginning at the previously identified location on the cost-effective curve, the PDT began investigating other frameworks adjacent to the cost-efficient frontier that included important features not in the cost-effective framework combinations. A number of additional frameworks were identified that addressed the identified important features such as the barrier islands in Subprovince 3. These additional frameworks (5410 and 5610) were grouped with the remaining cost-effective frameworks to form a tentative final array. The six frameworks in the tentative final array for the Deltaic Plain were 5110, 5410, 5610, 7002, 7410, 7610 and 7002. As indicated above framework 7002 is the terminal, or maximum output framework. This framework has been included in the tentative final array as a representation of the required incremental level of investment necessary to achieve the maximum level of beneficial output. **Figure 2-3** graphically displays the Plan Formulation Process from Phase III through the initial CE/ICA analysis.

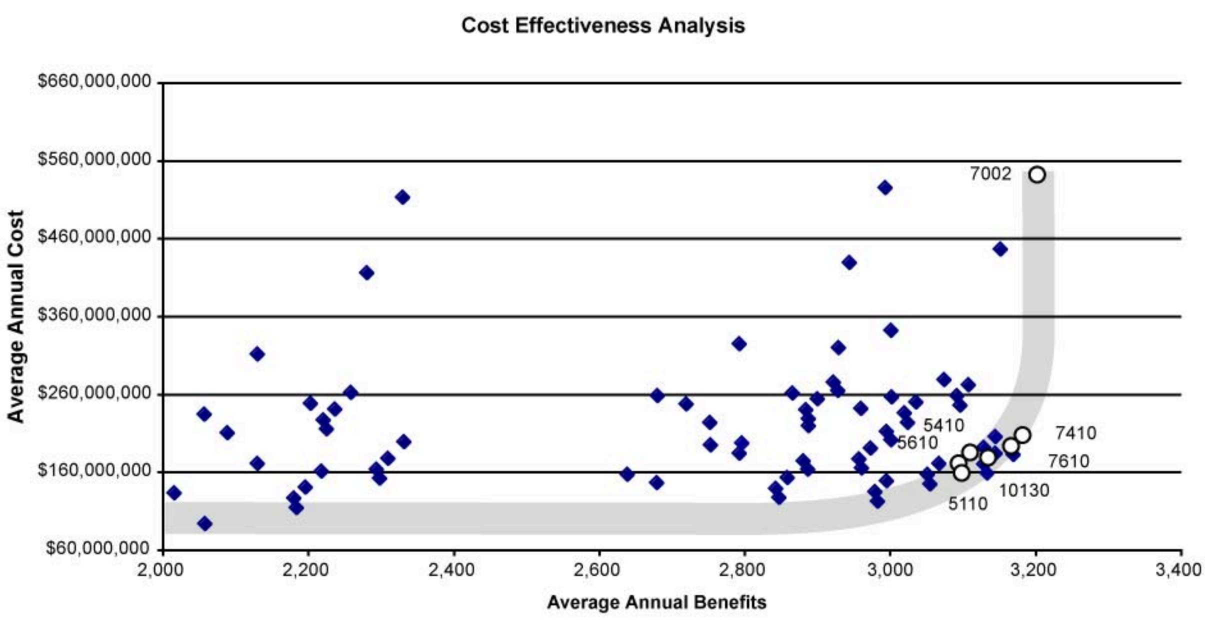


Figure 2-2. Preliminary Average Annual Costs and Average Annual Benefits for the Final Array of Alternative Frameworks for Subprovinces 1 to 3. *Note: the gray line denotes the cost efficient frontier.*

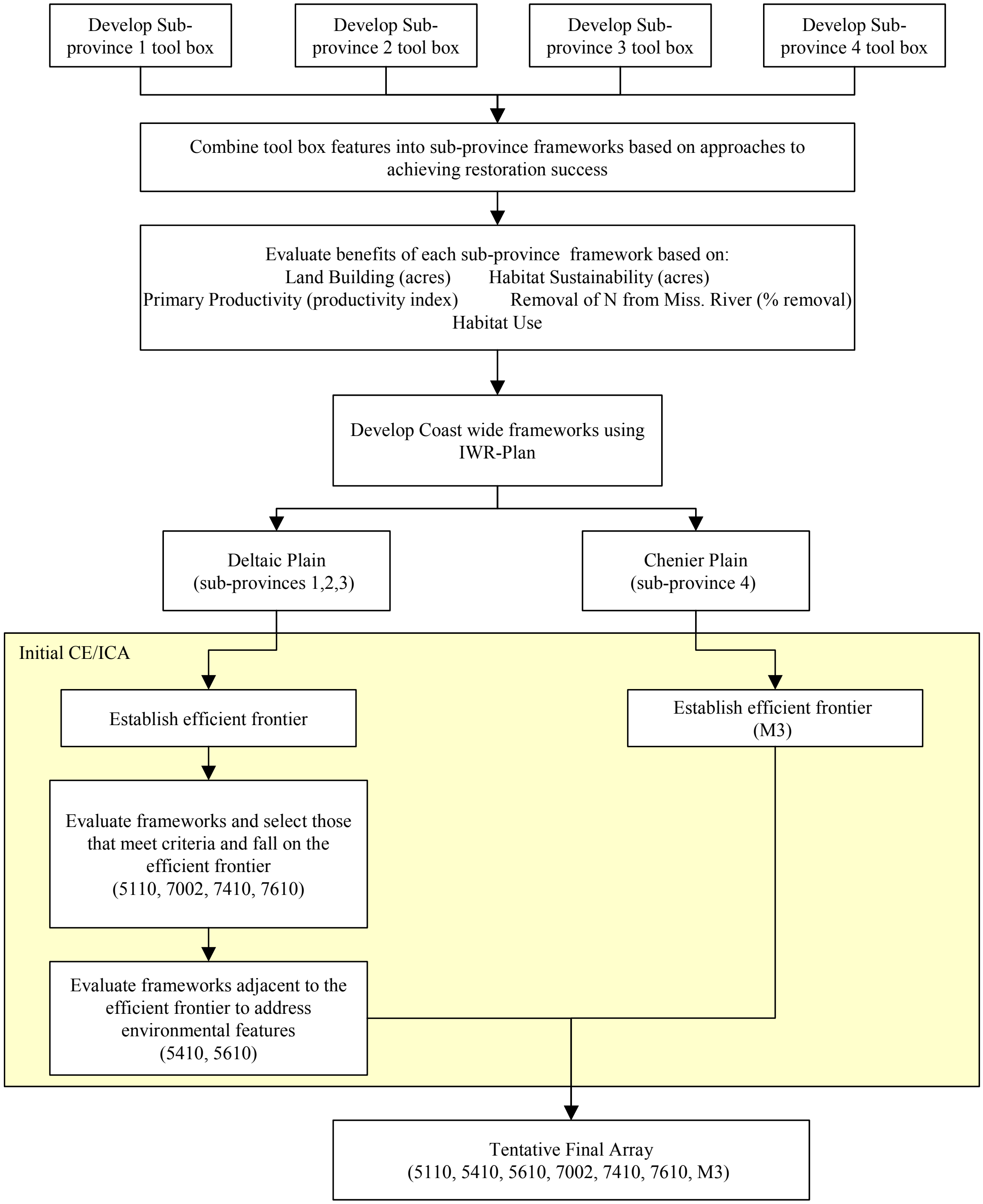


Figure 2-3. Plan formulation and framework selection process: Phase III through initial CE/ICA analysis

2.3.5.3 Development of supplemental frameworks to address completeness of final array for the Deltaic Plain

The vertical team, executive team, and individual members of the framework development team, reviewed the cost-effectiveness analysis and the PDT effort in developing the tentative final array. Following this review, the executive team directed the PDT to develop two supplemental frameworks to attempt to further address the criteria of incorporating environmentally important features. A second framework was desired to further assess the viability of incorporating large-scale features and the possibility of producing additional frameworks to redefine the upper limit of the efficient frontier. These frameworks were also intended to address the completeness of the final array since the tentative frameworks identified by the initial analysis omitted a number of larger-scale features that were viewed as potentially critical to long-range success. The output from the ecological modeling and the experience gained from that effort provided valuable insight regarding plan effectiveness. The results of that effort were reviewed to determine what specific restoration features might be introduced to create a more complete and effective framework.

The PDT reviewed the features, model outputs, and framework components for each subprovince. At the conclusion of this effort, the PDT assembled the two supplemental frameworks (N1 and N2), which were predominantly based on framework 5610. These two supplemental frameworks were identical, except that the second supplemental framework (N2) contained the large-scale Third Delta feature. Once the features of the supplemental frameworks were identified, preliminary costs and benefits were developed for the supplemental frameworks in a manner consistent with the previously analyzed coast wide frameworks. The data were incorporated into the IWR-Plan database. A second iteration of the CE/ICA was run to determine the position of the two supplemental frameworks relative to the existing cost-efficient frontier.

The CE/ICA analysis revealed that supplemental framework N1 created fewer benefits at similar cost than those in the efficient frontier. The second supplemental framework, N2, created slightly more output, but at a greater increased incremental cost than the tentative final array of frameworks. Neither framework plotted within the optimal range of the existing tentative final array of frameworks. In addition a review of the features included in the second supplemental framework revealed that several of the diversion features included in the framework could be redundant and potentially not compatible with the inclusion of the Third Delta feature. Framework 7002 also included the best available estimates for several of the features identified as elements of large-scale long-range concepts and included in supplemental framework N2. As a result, it was determined that the appropriate action would be to continue to develop supplemental framework N1 and include it along with framework 7002 in the final array. The inclusion of framework 7002 in the tentative final framework provides a gauge of the level of incremental cost required to achieve the maximum ecosystem benefits beyond those provided by frameworks identified as optimal in the cost effective analysis. This also provides some insight into the relative beneficial return for extremely large-scale long-range restoration features.

To further determine whether the combinable components of the supplemental framework had any specific strengths or weaknesses, another iteration of cost-effectiveness was executed for each subprovince. The study executive team reviewed this information and was able to identify an existing framework in Subprovince 2 that in combination with the N1 supplemental framework components in Subprovinces 1 and 3 could produce a modified supplemental framework that would be more complete and cost-effective. The data for the modified supplemental framework, which was labeled 10130 (based on the IWR-Plan system of numbering solution scales), was added to the IWR-Plan database. An additional iteration of the cost-effectiveness analysis revealed the new framework to be on the cost-effective curve and consistent with the position and criteria for the final array. Therefore, the seven frameworks in the tentative final array of frameworks for the Deltaic Plain were 5110, 5410, 5610, 7002, 7410, 7610, and 10130.

The final array of frameworks are all fairly close to the efficient frontier, and, given limitations of both the benefit and cost data, are within the margin of error for the efficient frontier. That is, given the level of accuracy in the model's prediction of benefits and limitations on our ability to estimate costs, it is not possible to state with certainty that the supplemental framework 10130 is less efficient than those on the efficient frontier. The exception, since the framework that produces the maximum possible output is always a component of the efficient frontier, is framework 7002, which has costs far in excess of frameworks which produce only slightly lower benefit levels, as illustrated in **figure 2-2**. Therefore, any of the frameworks, with the exception of 7002, could suffice as a cost-effective framework for the Deltaic Plain. **Figure 2-4** graphically represents the development and evaluation of the supplemental frameworks.

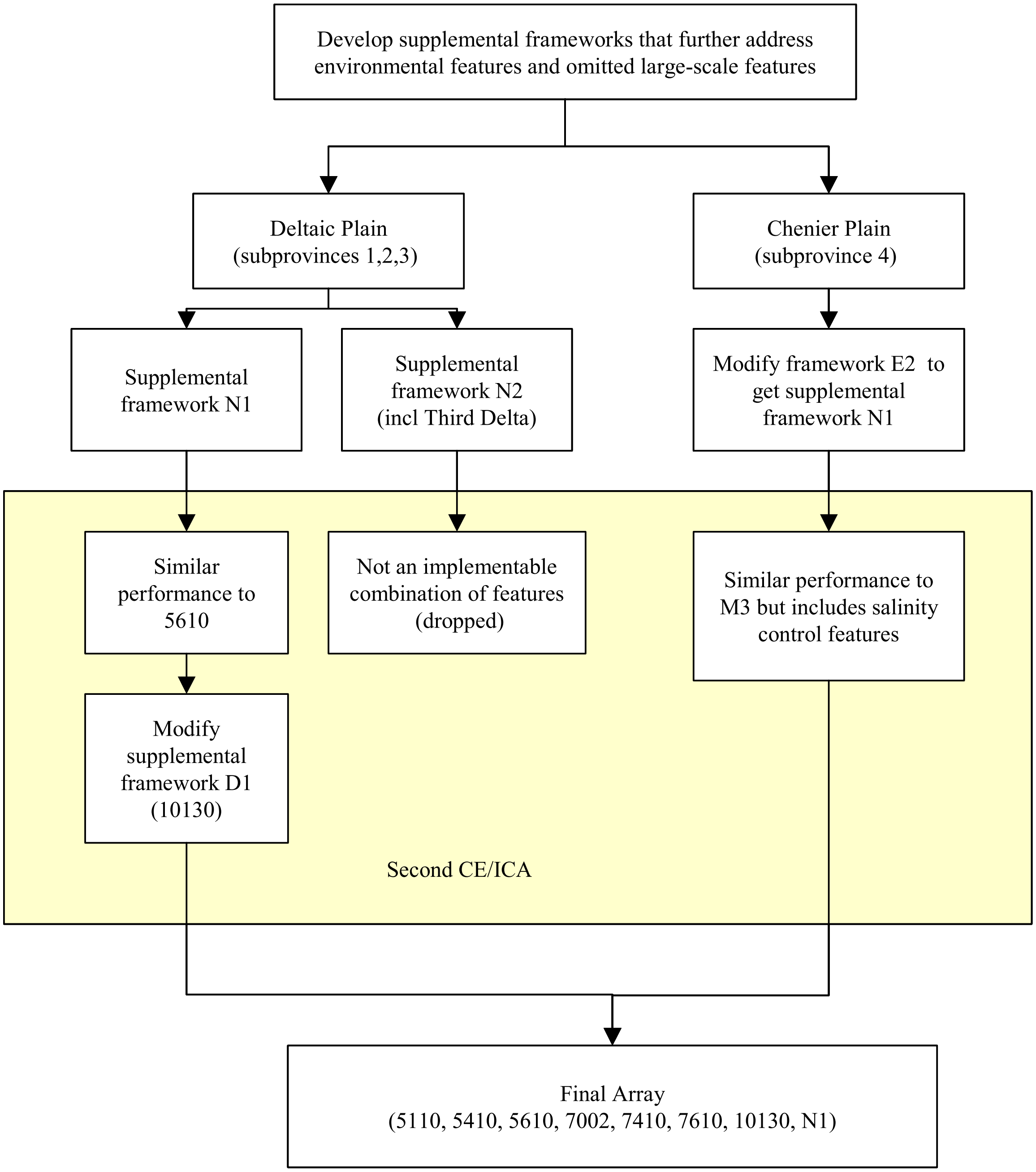


Figure 2-4. Plan formulation and framework selection process: development of supplemental frameworks and second CE/ICA analysis

2.3.5.4 Development of the final array for the Chenier Plain

Because habitats in the Chenier Plain were created by processes that did not include periodic overflows of the river to build and maintain land, the frameworks for Subprovince 4 were not constrained by the amount of water and sediment available in the Mississippi River and the resources used for restoration on Subprovinces 1 through 3. Consequently, the PDT evaluated Subprovince 4 separately from the other three subprovinces, which comprised the Deltaic Plain.

Because there is no nitrogen removal issue in the Chenier Plain and the habitat created in this area is expected to remain fairly uniform in quality, evaluation of Subprovince 4 frameworks was solely based on land creation. Any of the outcomes here could be combined with any of the seven frameworks in the final array for the Deltaic Plain.

The cost-effective analysis produced a cost-effective curve consisting of only one cost-effective framework, M3. The PDT reviewed the cost-effectiveness analysis results and recognized that framework M3 failed to appreciably address the core restoration strategy for the Chenier Plain of controlling estuarine salinities. In addition, the PDT suggested that the "Increase" planning scale be adopted as the minimum restoration level in this subprovince due to the relatively low rate of loss. Again, the Plan Formulation process from Phase III through the initial CE/ICA analysis is graphically depicted in **figure 2-3**.

2.3.5.5 Development of supplemental framework for final array for the Chenier Plain

The executive team, as well as the vertical team and members of the framework development team, again reviewed the cost-effectiveness analysis and the PDT effort in identifying the cost-effective frameworks for the Chenier Plain. The executive team directed the PDT to develop a supplemental framework to better address the core strategy. While not cost-effective, the relative ability of framework E2 to better address the core restoration strategy (i.e., salinity control) was suggested as a starting point to develop the supplemental framework. During a two-day meeting of the executive team and PDT, the PDT assembled the supplemental framework, which was based on the framework E2. The criteria concerning the identification and inclusion of any environmentally important features applied in the Deltaic Plain also applied to this subprovince.

Once the features of the supplemental alternative framework were identified, costs and benefits were developed for the framework in a manner consistent with the previously analyzed alternative frameworks. This data was incorporated into the IWR-Plan database. A second iteration of the CE/ICA was run to determine the position of the supplemental alternative framework relative to the efficient frontier. Once again, the supplemental framework was intended to add to the completeness of the final array.

Eight subprovince frameworks, including the supplemental framework and the No Action Alternative, were evaluated for the Chenier Plain (**figure 2-5**). As stated previously, the Chenier Plain was analyzed separately and thus frameworks that are not combinable were analyzed independently.

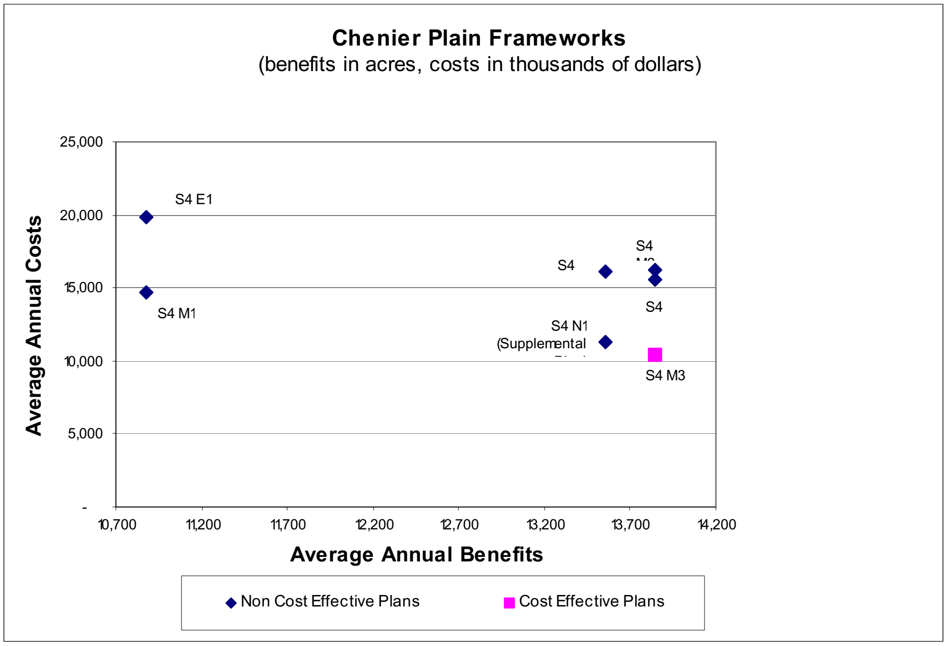


Figure 2-5. Costs and Benefits (acres) for all Chenier Plain Frameworks.

A second iteration once again resulted in the identification of only one cost-effective framework, M3. However, the added supplemental framework (N1) was similar in average annual cost but produced slightly fewer average annual benefits. The features in framework M3 failed to appreciably address the core restoration strategy for Subprovince 4, as previously identified by the PDT. Framework N1 included the major features of framework M3 in addition to features to address salinity control. As a result, framework M3 was dropped from the final array. The final array focuses on framework N1, the supplemental framework that was developed by modifying framework E2. Again, the Plan Formulation process from supplemental framework development through the second CE/ICA analysis is graphically presented in **figure 2-4**.

2.3.5.6 <u>Details of the final array of coast wide system frameworks</u>

As stated previously, the Chenier Plain framework can be added to any of the seven Deltaic Plain frameworks to construct coast wide frameworks, resulting in seven coast wide frameworks. **Table 2-7** identifies the subprovince framework components of each of the system frameworks identified in the final array. The subprovince frameworks considered, and the features included in them, can be found in **tables 2-3** through **2-6**. The final array of coast wide system frameworks identified a relatively tight grouping of possible alternatives. In comparing these alternatives, the PDT observed numerous cases of common features between the frameworks. The differences in restoration features between the frameworks, however, typically resulted in an observable difference in the make up of their beneficial outputs (i.e., the balance of marsh type and resultant species usage). The end result was that any of the frameworks in the final array could be a justifiable plan depending on the nuances applied in developing a single output value for their comparison.

In addition, the PDT recognized that the relative uncertainty of quantifying ecologic performance and sustainability versus the somewhat more certain quantification of implementation cost caused a variable effect on certainty across the range of features considered in the system wide frameworks. Particularly, larger-scale, longer range restoration features compared poorly in a comparative analysis. As a result, for the longer-range features included in the various frameworks, there were lower confidence limits that have implications for the overall timing of their implementation. Conversely, features that could be implemented and produce environmental outputs in the near-term resulted in a higher degree of confidence.

Table 2-7. Overview of Final Array of Coast wide Restoration Frameworks.

	Framework Identification						
	5110	**5610**	**5410**	**7610**	**7410**	**7002**	**10130**
Subprovince 1							
M2	X	X	X				
E1				X	X	X	
N1 (Modified M2)							X
Subprovince 2							
R1	X						
M1			X		X		
M3		X		X			
E3						X	
N1 (Modified R1)							X
Subprovince 3							
R1	X	X	X	X	X		
M1						X	
N1 (Modified R1)							X
Subprovince 4							
N1 (Modified E2)	X	X	X	X	X	X	X

Of the 111 features listed in **tables 2-3** through **2-6**, 79 features are contained in the final array of coast wide frameworks identified in **table 2-7**. Descriptions of the 79 features are found in section 3.3.6.1.

2.3.6 Phase VI - Development of Alternative LCA Restoration Plans

Upon the completion of Phase V efforts, with attention to the dynamic nature of the coastal ecosystem, the science and technology (S&T) uncertainties and model uncertainties, the Vertical Team and PDT redirected the plan formulation effort towards the identification of a plan that focused on critical restoration effort needs in the near-term, the next 5 to 10 years. The PDT determined that a LCA Plan would best meet the overall study objectives through inclusion of several complementary plan components that differ in scale and time. These would include:

- Near-term, highly certain feature concepts for development and implementation;
- Identified, feature-related uncertainties and potential methods or features to resolve them; and
- Large-scale and long-range feature concepts to be more fully developed.

Having identified the most efficient, effective, and complete combinations, of features within the final array of coast wide frameworks it was decided to not abandon the work that produced and screened those coast wide alternatives. The PDT believed that the formulation of frameworks and the identification and assessment of beneficial outputs accurately reflected the relative effectiveness and efficiency of the coast wide frameworks to meet the study planning objectives and affect coastal restoration. In meeting the set objectives and benefit parameters, in addition to being effective and efficient, the most critical restoration features should have been captured in these frameworks as well. The PDT determined that a resorting of the features included in the final alternative coast wide frameworks would provide a representative plan of those most promising critical restoration features.

The seven final coast wide frameworks were used as the starting point for the identification of alternative LCA near-term plans. The 79 restoration features that were combined into the coast wide frameworks of the final array primarily addressed areas of critical wetland loss, opportunities for the reestablishment of deltaic processes, and the protection and restoration of geomorphic features. The 79 features were the building blocks for alternative LCA Plans in Phase VI.

2.3.6.1 Description of the restoration features identified in the final array of coast wide frameworks

The PDT initially determined that the follow-on feasibility study process would analyze and optimize specific locations and dimensions for any restoration feature that would ultimately become a component of the LCA Plan that best met the objectives. Instead, general details about restoration features were included as part of this plan formulation process. For example, diversions were referred to as either small, medium, or large, where small equates to 1,000 to 5,000 cfs (30 to 150 cms) to diversions, medium to 5,000 to 15,000 cfs (150 to 450 cms) diversions, and large to greater than 15,000 cfs diversions. Additionally for features involving the use of dredged sediments borrow locations are typically not specified, however, consistent with guiding principle number 4, the use of sediment sources both renewable and external to the functional coastal system are expected to be identified in final decision and NEPA documents. More detailed cost information regarding the features is available at the District upon request. The features are shown on **figures 2-6** through **2-9**.

2.3.6.1.1 *Subprovince 1 feature descriptions*

Medium diversion at American/California Bays

This restoration feature provides for a medium non-structural, uncontrolled diversion from the Mississippi River at American/California Bays. The diversion feature would consist of an armored crevasse through the existing un-leveed riverbank into the fringe marsh and open water of the bay system. The objective of this feature is to increase sediment introduction into American/California Bays. The introduction of additional sediment would facilitate organic and mineral sediment deposition, improve biological productivity, and prevent further deterioration of the marshes.

Medium to large sediment diversion at American/California Bays

This restoration feature involves a large non-structural, uncontrolled sediment diversion from the Mississippi River with sediment enrichment at American/California Bays. The diversion feature would consist of an armored crevasse through the existing un-leveed riverbank into the fringe marsh and open water of the bay system. The objective of this feature is to maximize sediment inputs and spur large-scale land building in American/California Bays. This area was historically an outflow area of the Mississippi River, which received river discharges during flooding events. The creation and restoration of wetlands in American/California Bays would have the added benefit of stabilizing the Breton Sound marshes to the north by reducing marine influences from the Gulf of Mexico.

Rehabilitate Bayou Lamoque structure as a medium diversion

This feature provides for the refurbishment and operation of a pair of diversion structures, regulating the flow of Mississippi River water into Bayou Lamoque, a former distributary of the Mississippi River. The existing Bayou Lamoque diversion structures require mechanical rehabilitation and operational security modifications. The remote location of these structures and the frequent occurrence of vandalism have resulted in an inability to ensure consistent and reliable operation. The objective of this feature is to increase and maintain riverine inflows into Bayou Lamoque. The introduction of additional freshwater would facilitate organic and sediment deposition, improve biological productivity, and prevent further deterioration of the marshes. This feature is located in the vicinity of a historic crevasse.

Medium diversion at Bonnet Carré Spillway

This restoration feature would be located at the existing Bonnet Carré Spillway and involve a reevaluation of the existing authorized project. The spillway is currently operated to remove excess water from the Mississippi River during flooding events and pass the water through the Bonnet Carré Spillway into Lake Pontchartrain. The restoration feature consists of a medium diversion with east and west branches into the La Branche wetlands and Manchac land bridge - diverted through a modified segment of the existing flood control structure and redirected through the guide levees into adjacent wetlands. The objective of the project is to decrease salinities in Lake Pontchartrain and the surrounding marshes, especially the La Branche Wetlands, and to add nutrients and some sediment to these marshes and swamps. This feature is located in the vicinity of a historic crevasse.

Small diversion at Convent/Blind River

This restoration feature involves a small diversion from the Mississippi River into Blind River through a new control structure. The objective of this feature is to introduce sediment and nutrients into the southeast portion of Maurepas Swamp. This feature is intended to operate in conjunction with the Hope Canal diversion to facilitate organic deposition in the swamp, improve biological productivity, and prevent further swamp deterioration.

Medium diversion at Fort St. Philip

This restoration feature provides for a medium diversion from the Mississippi River into marshes northeast of Fort St. Philip, between the Mississippi River and Breton Sound. Objectives of this feature are to reduce wetland loss and facilitate riverine influences to these marshes. The diversion would facilitate organic deposition in and biological productivity of the marshes by increasing freshwater circulation and providing sediment and nutrients to the system.

Small diversion at Hope Canal

This restoration feature involves a small diversion from the Mississippi River through a new control structure at Hope Canal. The objective is to introduce sediment and nutrients into Maurepas Swamp south of Lake Maurepas. The introduction of additional freshwater via the diversion would facilitate organic deposition, improve biological productivity, and prevent further deterioration of the swamp. Work for this feature has been initiated in engineering and design and NEPA compliance under CWPPRA.

Medium diversion at White's Ditch

This restoration feature, located at White's Ditch, downstream of the existing Caernarvon diversion structure, provides for a medium diversion from the Mississippi River into the central River aux Chenes area using a controlled structure. The objective of the feature is to provide additional freshwater, nutrients, and fine sediment to the area between the Mississippi River and River aux Chenes ridges. This area is currently isolated from the beneficial effects of the Caernarvon freshwater diversion. The introduction of additional freshwater would facilitate organic sediment deposition, improve biological productivity, and prevent further deterioration of the marshes. This feature is located in the vicinity of a historic crevasse. Follow-up feasibility-level analysis will determine the ultimate size of the diversion.

Sediment delivery via pipeline at American/California Bays

This restoration feature provides for sediment delivery via pipeline through programmatic sediment mining from the Mississippi River. The moderately deep (6 to 10 feet [1.8 to 3 meters]) open water in this bay system requires a large volume of sediment to create wetlands. The objective of this feature is to create wetlands in the American/California Bays.

Sediment delivery via pipeline at Central Wetlands

This restoration feature provides for placement of sediment mined from the Mississippi River into the Central Wetlands adjacent to the MRGO and Violet canal, via pipeline. The objective of this feature is to create wetlands by placing dredged sediment in the shallow (1 to 2 feet [0.3 to 0.6 meters]) open waters of the marshes. Placement of this dredged material would counteract marsh breakup by providing sediment and nutrients to renourish the area. This feature is located in the vicinity of a historic crevasse.

Sediment delivery via pipeline at Fort St. Philip

This feature provides for sediment delivery at Fort St. Philip via programmatic sediment mining from the Mississippi River. The objective of the feature is to create and/or restore marsh habitat by depositing sediment in appropriate moderately shallow (3 to 5 feet [0.9 to 1.5 meters]) open water areas in the vicinity of Fort St. Philip. Increasing the area and improving the function of these marshes would facilitate biological productivity of the marshes and reduce wetland loss.

Sediment delivery via pipeline at Golden Triangle

This restoration feature provides for sediment delivery via sediment mined from the Mississippi River and placed in the area formed by the confluence of the MRGO, GIWW, and Lake Borgne. The objective of the feature is to create and/or restore marsh habitat by depositing sediment in appropriate shallow (1 to 2 feet [0.3 to 0.6 meters]) open water in the area adjacent to these three water bodies. Increasing the area and improving the function of these marshes would facilitate biological productivity of the marshes and reduce wetland loss.

Sediment delivery via pipeline at La Branche Wetlands

The proposed restoration feature includes the dedicated dredging of sediment from the Mississippi River, which would be delivered via pipeline to shallow (1 to 2 feet [0.3 to 0.6 meters]) open waters within the La Branche Wetlands in the southwest corner of Lake Pontchartrain. The creation and restoration of these marshes would facilitate improved biological productivity and reduce wetland loss. This feature is located in the vicinity of a historic crevasse.

Sediment delivery via pipeline at Quarantine Bay

This restoration feature provides for sediment delivery to Quarantine Bay via programmatic sediment mining from the Mississippi River. The objective of the feature would be to create wetland habitat through the placement of dredge sediment in the moderately shallow (3 to 5 feet [0.9 to 1.5 meters]) open waters of Quarantine Bay.

Opportunistic use of Bonnet Carré Spillway

This restoration feature involves freshwater introductions from the Mississippi River via the opportunistic use of the existing flood control structure at the Bonnet Carré Spillway. The spillway is currently operated to remove excess water from the Mississippi River during flooding events and pass the water through the Bonnet Carré Spillway into Lake Pontchartrain. This feature would allow for freshwater introductions to be delivered to Lake Pontchartrain and the adjacent La Branche wetlands during times of high river water levels. Thus, the river introductions would help reduce salinities in the southwest corner of Lake Pontchartrain and nourish the intermediate and brackish marshes in La Branche with sediment and nutrients. This feature is located in the vicinity of a historic crevasse.

Increase Amite River Diversion Canal influence by gapping banks

This restoration feature involves the construction of gaps in the existing dredged material banks of the Amite River Diversion Canal. The objective of this feature is to allow floodwaters to introduce additional nutrients and sediment into western Maurepas Swamp. The exchange of flow would occur during flood events on the river and from the runoff of localized rainfall events. This feature would provide nutrients and sediment to facilitate organic deposition in the swamp, improve biological productivity, and prevent further swamp deterioration.

Marsh nourishment on New Orleans East land bridge

This restoration feature involves wetland creation through the dedicated dredging of sediment from lake bottom sources. The objective of this feature is to create wetlands by placing dredged sediment in the shallow open waters within the land bridge separating Lakes Pontchartrain and Borgne. This area has experienced wetland deterioration and loss due to erosion from wave energies in Lake Borgne. Reinforcing the land bridge between the two lakes would help maintain the salinity gradients in Lake Pontchartrain and ensure the long-term sustainability of the wetland ecosystems in the area.

Mississippi River Delta Management Study

This restoration concept requires detailed investigations to address the maximization of river resources, such as excess freshwater and sediment, for wetland restoration. The objective of this concept is to greatly increase the deposition of Mississippi River sediment on the shallow continental shelf, while ensuring navigation interests. Sediment, nutrients, and freshwater would be re-directed to restore the quality and sustainability of the Mississippi River Deltaic Plain, its coastal wetland complex, and the Gulf of Mexico. The study would investigate potential modifications to existing navigation channel alignments and maintenance procedures and requirements.

Mississippi River Gulf Outlet (MRGO) environmental restoration features

This restoration opportunity involves the implementation of the environmental restoration features considered in the MRGO Reevaluation Study. In response to public concerns, adverse environmental effects, and national economic development considerations, an ongoing study is reevaluating the viability of operation and maintenance of this authorized navigation channel. Since the construction of the MRGO, saltwater intrusion and ship wake erosion have degraded large expanses of fresh and intermediate marshes and accelerated habitat switching from freshwater marshes to brackish and intermediate marshes in the Biloxi marshes, the Central Wetlands, and the Golden Triangle wetlands. This environmental restoration study would evaluate the stabilization of the MRGO banks and various environmental restoration projects, including evaluation of freshwater reintroductions into the Central Wetlands, possible channel depth modification, and other ecosystem restoration measures. Implementation of this feature would preserve estuarine wetlands and important structural features of the lake and marsh landscape.

Modification of Caernarvon diversion

The Caernarvon diversion structure, constructed on the Mississippi River in 1992 near the Breton Sound marshes, has a maximum operating capacity of 8,000 cfs (286 cms). The structure has been operated as a salinity management feature, with freshwater introductions ranging between 1,000 cfs to 6,000 cfs (36 cms to 214 cms), but in general averaging less than half of the structure's capacity. The primary purpose of the existing Caernarvon project has been to maintain salinity gradients in the central portion of Breton Sound. This operation, in effect, partially restored the historic functions of marsh nourishment (e.g., freshwater inflow, providing nutrients and sediment to the marsh, and countering the effects of subsidence). The proposed restoration feature study would assess changes in the operation of the Caernarvon project to increase wetland creation and restoration outputs for this structure. Modified operation of this structure would allow an increase in the freshwater introduction rate, perhaps 5,000 cfs (178 cms) on average, to accommodate the wetland building function of the system. This study would identify any changes to this feature's operation that would increase restoration outputs. The introduction of additional freshwater would facilitate organic and sediment deposition, improve biological productivity, and prevent further deterioration of the marshes. This feature is located in the vicinity of a historic crevasse. Any proposed change in purpose that would require modification of the existing authorization for this structure would be submitted for Congressional approval.

Rehabilitate Violet Siphon for increased freshwater influence to Central Wetlands

This restoration feature involves the rehabilitation of the existing Violet Siphon water control structure, which is located between the Mississippi River and the MRGO, in the Central Wetlands. The objectives of this feature are to improve the operation of the Violet Siphon and enhance freshwater flows into the Central Wetlands. This action would increase freshwater in the wetlands and nourish the remaining swamp and intermediate marshes. The restoration of wetlands and improvement in ecosystem function produced by this feature would be increased by the freshwater introductions via the IHNC lock feature. This feature is located in the vicinity of a historic crevasse.

Post authorization change for the diversion of water through Inner Harbor Navigation Canal for increased freshwater influence into Central Wetlands

This restoration feature calls for a post-authorization modification of the IHNC lock. Modifications would incorporate culverts and controls to divert freshwater from the Mississippi River through the IHNC to the Central Wetlands. The objectives of this feature are to introduce freshwater and nutrients into the intermediate and brackish marshes of the Central Wetlands, boost plant productivity, and reduce elevated salinities. This restoration feature could also increase the benefits produced by the Violet Siphon structure rehabilitation restoration feature.

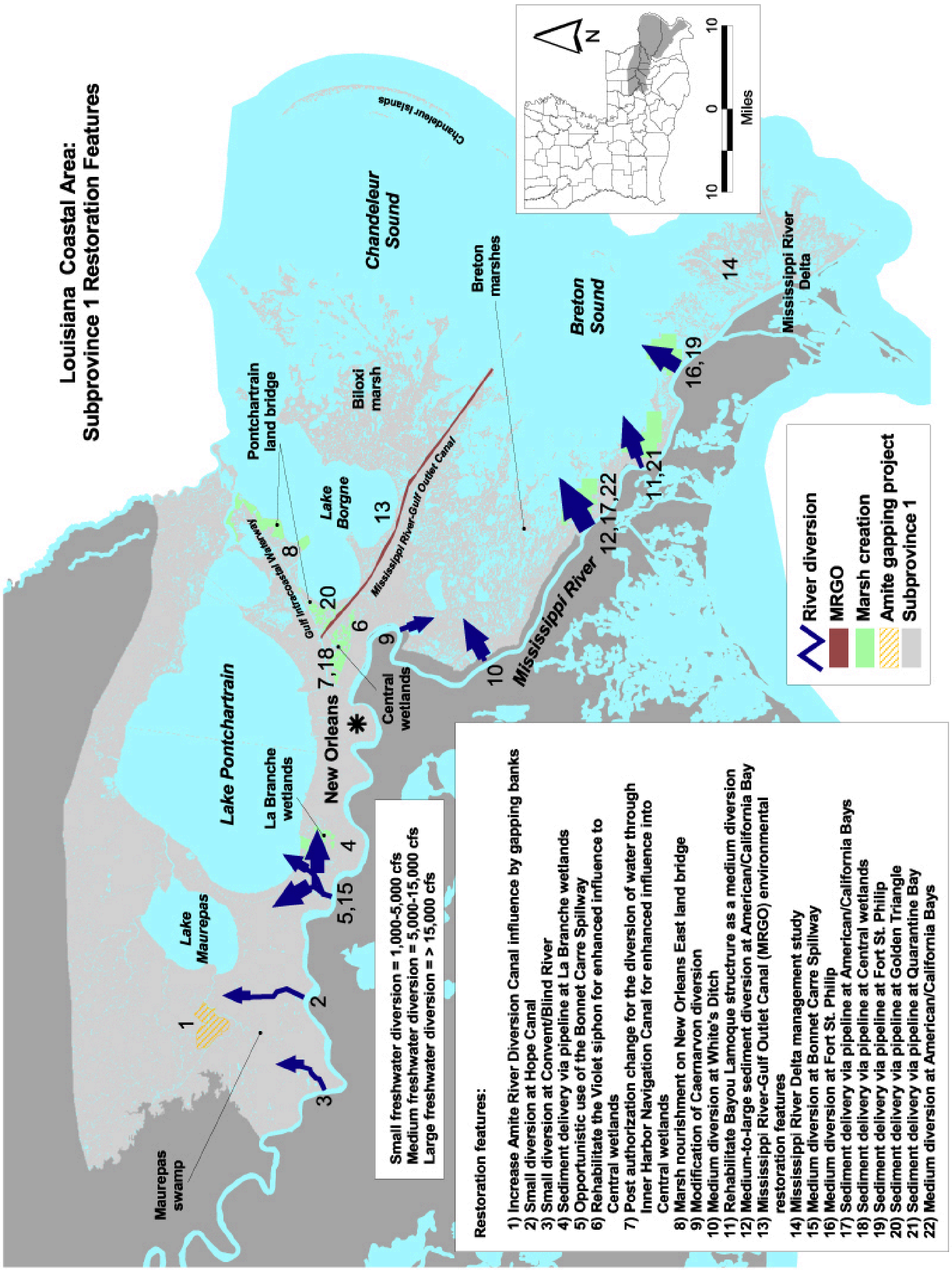


Figure 2-6. Subprovince 1 Restoration Features Identified in the Final Array of Coast Wide Frameworks.

2.3.6.1.2 *Subprovince 2 Feature Descriptions*

Large diversion at Boothville with sediment enrichment

This restoration feature provides for a large nonstructural, uncontrolled sediment diversion from the Mississippi River near Boothville into the Yellow Cotton/Hospital Bays area. The objective of this feature is to create wetlands by diverting sediment in the moderately deep (6 to 10 feet [1.8 to 3 feet]) open waters of Yellow Cotton / Hospital Bays. The freshwater and nutrients would also increase vegetative stability in the fringing marshes and along the Bayou Grand Liard ridge. Ultimately, sediment would reach and supplement the barrier shoreline between Red Pass and the Empire to the gulf waterway. Sediment enrichment assumes use of 20-inch (51 centimeter) dredge at capacity for three months yielding 1,468,000 cubic yards (1,120,000 cubic meters) each year. The diversion would maximize sediment and nutrient inputs and spur large-scale land building in the extreme southeastern portion of Barataria Bay.

Small diversion at Donaldsonville

This restoration feature involves a small diversion from the Mississippi River through a new control structure at Donaldsonville. The objective is to introduce freshwater, sediment, and nutrients into upper Bayou Verret, which is located to the northwest of Lac Des Allemands, to improve water quality and promote plant productivity. The wetland ecosystem in the area is classified as wetland forest, consisting primarily of bottomland hardwood forests. This feature is intended to operate in conjunction with three other small diversions in the area.

Small diversion at Edgard

This restoration feature involves a small diversion from the Mississippi River through a new control structure at Edgard. The objective is to introduce freshwater, sediment, and nutrients into Bayou Fortier, which is located to the northeast of Lac Des Allemands, to improve water quality and promote plant productivity. The wetland ecosystem in the area is classified as wetland forest, consisting primarily of bottomland hardwood forest. This feature is intended to operate in conjunction with three other small diversions in the area.

Medium diversion at Edgard with sediment enrichment

This restoration feature involves a medium diversion from the Mississippi River through a new control structure at Edgard. The objective is to introduce freshwater, sediment, and nutrients into Bayou Fortier, which is located to the northeast of Lac des Allemands, to improve water quality and promote plant productivity. The wetland ecosystem in the area is classified as wetland forest, consisting primarily of bottomland hardwood forest. Sediment enrichment would involve use of 12-inch (31 centimeter) dredge for three months. Discharge of effluent upstream of the diversion intake would allow the capture of silts and very fine sands only.

Medium diversion at Fort Jackson - Alternative to Boothville diversion

This restoration feature provides for a medium non-structural, uncontrolled sediment diversion from the Mississippi River near Fort Jackson into the Yellow Cotton/Hospital Bays area. The objective of this feature is to create wetlands by diverting sediment in the moderately deep (6 to 10 feet [1.8 to 3 feet]) open waters of Yellow Cotton/Hospital Bays. The associated freshwater and nutrients would also increase vegetative stability in the fringing marshes and along the Bayou Grand Liard ridge. The diversion would maximize sediment and nutrient inputs and spur land building in the extreme southeastern portion of Barataria Bay.

Large diversion at Fort Jackson with sediment enrichment - Alternative to Boothville diversion

This restoration feature provides for a large (50,000 to 100,000 cfs [1,800 to 3,600 cms]) non-structural, uncontrolled sediment diversion from the Mississippi River near Fort Jackson into the Yellow Cotton/Hospital Bays area. The objective of this feature is to create wetlands by diverting sediment in the moderately deep (6 to 10 feet [1.8 to 3 feet]) open waters of Yellow Cotton / Hospital Bays. The associated freshwater and nutrients would also increase vegetative stability in the fringing marshes and along the Bayou Grand Liard ridge. Sediment enrichment assumes use of 20-inch (51 centimeter) dredge at capacity for three months yielding 1,468,000 cubic yards (1,120,000 cubic meters) each year. Ultimately, sediment would reach and supplement the barrier shoreline between Red Pass and the Empire to the gulf waterway. The diversion would maximize sediment and nutrient inputs and spur large-scale land building in the extreme southeastern portion of Barataria Bay.

Small diversion at Lac des Allemands

This restoration feature involves a small diversion from the Mississippi River through a new control structure at Lac des Allemands. The objective is to introduce freshwater, sediment, and nutrients into Bayou Becnel, which is located to the north of Lac des Allemands, to improve water quality and promote plant productivity. The wetland ecosystem in Bayou Becnel and surrounding Lac des Allemands area is classified as wetland forest, consisting primarily of bottomland hardwood forest. This feature is intended to operate in conjunction with three other small diversions in the area.

Medium diversion at Lac des Allemands with sediment enrichment

This restoration feature involves a medium diversion from the Mississippi River through a new control structure at Lac des Allemands. The objective is to introduce freshwater, sediment, and nutrients into Bayou Becnel, which is located to the north of Lac des Allemands, to improve water quality and promote plant productivity. The wetland ecosystem in Bayou Becnel and surrounding Lac des Allemands area is classified as wetland forest, consisting primarily of bottomland hardwood forest. Sediment enrichment would involve use of 12-inch (31 centimeter) dredge for three months. Discharge of effluent upstream of the diversion intake would allow the capture of silts and very fine sands only. This feature is intended to operate in conjunction with three small diversions in the area.

Medium diversion with dedicated dredging at Myrtle Grove

This restoration feature involves a medium diversion of the Mississippi River near Myrtle Grove through a new control structure. The diversion would provide additional sediment and nutrients to nourish highly degraded existing fresh to brackish wetlands in shallow open water areas. This reintroduction would ensure the long-term sustainability of these marshes by increasing plant productivity, thereby preventing future loss. The introduction of sediment to this area would also promote the infilling of shallow open water areas both through deposition and marsh expansion. Dedicated dredging of sediment mined from the Mississippi River would complement this feature. This feature is located in the vicinity of a historic crevasse. Work has been initiated on engineering and design and NEPA compliance under CWPPRA.

Large diversion at Myrtle Grove with sediment enrichment

This restoration feature involves a large sediment diversion from the Mississippi River near Myrtle Grove through a new control structure. The diversion would provide additional sediment and nutrients to nourish highly degraded existing fresh to brackish wetlands in shallow open water areas throughout the central Barataria basin. This reintroduction would allow the creation of new wetland in expansive open water and bay areas and ensure the long-term sustainability of currently degraded marshes by increasing plant productivity, thereby preventing future loss. The additional introduction of sediment by enrichment assumes use of 30-inch dredge at capacity for three months yielding 6,293,000 cubic yards [4,810,000 cubic meters] each year. This feature is located in the vicinity of a historic crevasse.

Small diversion at Pikes Peak

This restoration feature involves a small diversion from the Mississippi River through a new control structure at Pikes Peak. The objective is to introduce freshwater, sediment and nutrients into Bayou Chevreuil, which is located to the north of Lac Des Allemands, to improve water quality and promote plant productivity. The wetland ecosystem in the area is classified as wetland forest, consisting primarily of bottomland hardwood wetlands. This feature is intended to operate in conjunction with three other small diversions in the area.

Barataria Basin barrier shoreline restoration

This restoration feature involves mining of offshore sediment sources to reestablish sustainable barrier islands. The feature is based on designs developed in the LCA Barataria Barrier Island Restoration study and assumes a 3,000-foot [914 meter] wide island footprint. This feature originally considered restoration elements for all the major reaches of the Barataria barrier-shoreline chain. However, for inclusion in the near-term plan some consideration to the most critically needed elements of the chain. The most critical areas of this chain, however, include the Caminada-Moreau Headland (an area between Belle Pass and Caminada Pass) and Shell Island (a barrier island in the Plaquemines barrier island system). These barrier shoreline segments are critical components of the Barataria shoreline. The Shell Island segment has been nearly lost and failure to take restorative action could result in the loss of any future options for restoration. This would result in permanent modification of the tidal hydrology of the Barataria

Basin. The Caminada-Moreau Headland protects the highest concentration of near-gulf oil and gas infrastructure in the coastal area. This reach of the Barataria shoreline also supports the only land-based access to the barrier shoreline in the Deltaic Plain. These critical endpoints in the Barataria chain also serve as sources of material for the littoral system delivering sediment to the remainder of the chain.

Implement the LCA Barataria Basin Wetland Creation and Restoration Study

This feature involves implementation of components of the LCA Barataria Basin Wetland Creation and Restoration Study. The wetlands in the lower Barataria Basin have experienced wetland deterioration due to subsidence, a lack of circulation, saltwater intrusion, and a paucity of sediment and nutrients. Sediment dredged from offshore borrow sites would be placed at specific sites near Bayou Lafourche in the Caminada Headland to create and restore marsh and ridge habitat in the area.

Modification of Davis Pond diversion

The Davis Pond diversion structure, constructed in 2002 in upper Barataria Basin, has a maximum operating capacity of 10,600 cfs [378 cms]. The structure has been operated as a salinity management feature, with freshwater introductions from the Mississippi River ranging from 1,000 cfs up to 5,000 cfs [36 cms to 178 cms] averaging, to this point in time, considerably less than half of the structure's capacity. The primary purpose of the existing Davis Pond project has been to maintain salinity gradients in the central portion of Barataria Basin. This operation, in effect, partially restored the historic functions of marsh nourishment (e.g., freshwater inflow, providing nutrients and sediment to the marsh, and countering the effects of subsidence). This restoration feature study would assess changes in the operation of the Davis Pond project to increase wetland creation and restoration outputs. Modified operation of this structure could potentially result in an increase in the freshwater introduction rate, perhaps 5,000 cfs [178 cms] on average, to accommodate the wetland building function of the system. This study would identify changes to feature's operation that would increase restoration outputs. The introduction of additional freshwater would facilitate organic and sediment deposition, improve biological productivity, and prevent further deterioration of the marshes. This feature is located in the vicinity of a historic crevasse. Any proposed change in purpose that would require modification of the existing project authorization would be submitted for Congressional approval.

Sediment delivery via pipeline at Bastian Bay/Buras

This restoration feature provides for sediment delivery via pipeline through programmatic sediment mining from the Mississippi River. The moderately deep (6 to 10 feet [1.8 to 3 feet]) open water in this bay system requires a large volume of sediment to create wetlands. The objective of this feature is to create wetlands in the highly degraded Bastian Bay and Buras area.

Sediment delivery via pipeline at Empire

This restoration feature provides for sediment delivery via pipeline through programmatic sediment mining from the Mississippi River. The moderately deep (6 to 10 feet [1.8 to 3 feet]) open water in Bay Adams and Barataria Bay requires a large volume of sediment to create wetlands. The objective of this feature is to create wetlands in the highly degraded areas south and west of Empire.

Sediment delivery via pipeline at Main Pass (Head of Passes)

This feature provides for sediment delivery via programmatic sediment mining from the Mississippi River utilizing a sediment trap above the Head of Passes. The estimated annual yield of dredge material from the sediment trap is 9 million cubic yards [6.9 million cubic meters]. The objective of this feature is to create wetlands in the degraded areas in the east and west portions of the Mississippi River Delta south of Venice.

Third Delta (Subprovinces 2 & 3)

This feature provides for a large diversion from the Mississippi River through a new control structure in the vicinity of Donaldsonville. This feature provides for an approximately 240,000 cfs diversion at maximum river stage. Flows would be diverted into a newly constructed conveyance channel (parallel to Bayou Lafourche) extending approximately 55 miles [88 kilometers] from the initial point of diversion to the eventual point of discharge. Diverted flow would be divided equally at a point north of the GIWW to enable the creation of a deltaic wetlands complex in each of the Barataria and Terrebonne Basins. A possible alternative configuration would involve a 120,000 cfs [4300 cms] diversion at maximum river stage into the Barataria Basin only. Enrichment of this diversion would also be considered and assumes use of 30-inch [77 cm] dredge at capacity for three months yielding 6,293,000 cubic yards [4,810,000 cubic meters] each year. The study requires detailed investigations of flood control, drainage, and navigation impacts in addition to environmental and design efforts because it would require construction either through wetlands or prime farmland.

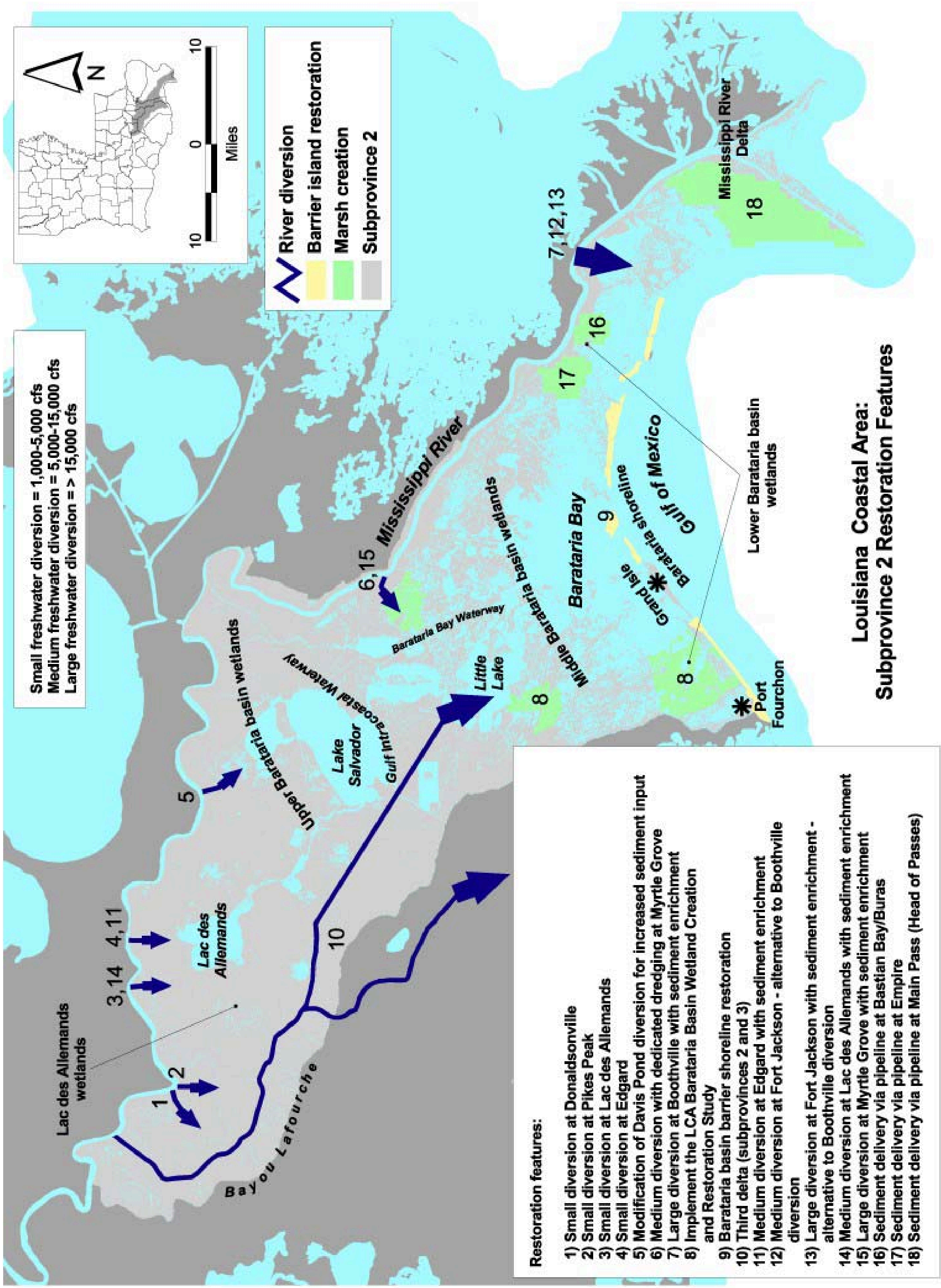


Figure 2-7. Subprovince 2 Restoration Features Identified in the Final Array of Coast Wide Frameworks.

2.3.6.1.3 Subprovince 3 feature descriptions

Backfill pipeline canals

This restoration feature provides for the backfilling of pipeline canals south of Catfish Lake. The Twin Pipeline canals in this area are crossed by numerous oilfield canals, which have greatly altered natural water circulation patterns. The 63,300 feet [19,300 meters] of pipeline canals would be filled at strategic locations to restore primary water circulation through Grand Bayou Blue. The retention time of Atchafalaya and Bayou Lafourche (pumped) flows would be increased to benefit affected wetlands.

Small Bayou Lafourche reintroduction

This restoration feature would reintroduce flow from the Mississippi River into Bayou Lafourche. The piped flow would be continuous and would freshen and reduce loss rates for the wetlands between Bayous Lafourche and Terrebonne, south of the GIWW.

Convey Atchafalaya River water to Northern Terrebonne marshes - via a small diversion in the Avoca Island levee, repairing eroding banks of the GIWW, and enlarging constrictions in the GIWW below Gibson and in Houma, and Grand Bayou conveyance channel construction/enlargement

This restoration feature would increase existing Atchafalaya River influence to central (Lake Boudreaux) and eastern (Grand Bayou) Terrebonne marshes via the GIWW by introducing flow into the Grand Bayou basin by enlarging the connecting channel (Bayou L'Eau Bleu) to capture as much of the surplus flow (max. 2000 to 4000 cfs [70 to 140 cms]) that would otherwise leave the Terrebonne Basin. Several alternatives would be evaluated through hydrologic models; however in all cases, gated control structures would be installed to restrict channel cross-section to prevent increased saltwater intrusion during the late summer and fall when riverine influence is typically low. Some alternatives may include auxiliary freshwater distribution structures. This feature also includes increasing freshwater supply through repairing banks along the GIWW, enlarging constrictions in the GIWW, and diverting additional Atchafalaya River freshwater through the Avoca Island Levee and into Bayou Chene/GIWW system.

Freshwater introduction south of Lake De Cade

This restoration feature is intended to improve Atchafalaya flows to Terrebonne wetlands between Lake De Cade, Bayou du Large, and Lake Mechant by constructing three small conveyance channels along the south shore of Lake De Cade to the Small Bayou La Pointe area. Channel flows would be controlled by structures that could be actively operated. Lowering salinities and increasing nutrient inputs would reduce intermediate marsh losses.

Freshwater introduction via Blue Hammock Bayou

This restoration feature would increase flow from the Atchafalaya River to the southwest Terrebonne wetlands by increasing the cross-section of Blue Hammock Bayou. This would increase the distribution of Atchafalaya flows from Four League Bay to the Lake Mechant wetlands. Grand Pass and Buckskin Bayou, outlets of Lake Mechant, would be reduced in cross section to increase the retention and benefits of Atchafalaya nutrients, sediment, and freshwater in these estuarine wetlands. Additional marsh would also be created with dredged material.

Increase sediment transport down Wax Lake Outlet

This restoration feature would increase sediment transport down Wax Lake Outlet by extending the outlet northward through Cypress Island to connect to the Atchafalaya Main Channel. Currently, the Wax Lake Outlet flows passes over the relatively shallow Six Mile Lake before entering the outlet. This restoration feature would connect the deep outlet directly to the deep Atchafalaya Main Channel thereby increasing bed load sediment transported to the Wax Lake Outlet Delta.

Maintain land bridge between Caillou Lake and Gulf of Mexico

This restoration feature would maintain the land bridge between the gulf and Caillou Lake by placing shore protection in Grand Bayou du Large to minimize saltwater intrusion. This feature would involve rock armoring or marsh creation to plug/fill broken marsh areas on the west bank of lower Grand Bayou du Large, to prevent a new channel from breaching the bayou bank and allowing a new connection with Caillou Lake. Some gulf shore armoring would be needed to protect these features from erosion on the gulf shoreline. Gulf shoreline armoring might be required where shoreline retreat and loss of shoreline oyster reefs has allowed increased water exchange between the gulf and the interior water bodies (between Bay Junop and Caillou Lake). Some newly opened channels would be closed to restore historic cross-sections of exchange points. By reducing marine influences in these interior areas, this feature would allow increased freshwater influence from Four League Bay to benefit area marshes.

Maintain land bridge between Bayous du Large and Grand Caillou

This restoration feature provides for construction of a land bridge between Bayous du Large and Grand Caillou south of Falgout Canal and northeast of Caillou Lake. A grid of numerous trenasses, a small human-made channel for navigation, has artificially increased the hydrologic connection between interior marshes with Caillou Lake and adjoining water bodies. This problem would be addressed by depositing hydraulically dredged material to close the trenasses and areas of broken marsh to create a continuous berm of “high marsh” in the area. This berm would separate the higher, healthy brackish/saline marshes bordering the northeast end of Caillou Lake from the deteriorating inland intermediate/brackish marshes. It would also allow the freshwater flowing down the HNC and Bayou Grand Caillou to have a greater influence on interior marshes through existing water exchange points along Bayou Grand Caillou, north of the proposed land bridge.

Maintain northern shore of East Cote Blanche Bay at Point Marone

This restoration feature would protect the north shore of East Cote Blanche Bay from Point Marone to Jackson Bayou. Bay shoreline would be stabilized to protect the interior wetland water circulation patterns in the Cote Blanche Wetlands CWPPRA project. The feature was designed to increase the retention time of the Atchafalaya flows moving from the GIWW to East Cote Blanche Bay.

Maintain Timbalier land bridge

This restoration feature provides for maintaining the Timbalier land bridge in the upper salt marsh zone. A 2,000-foot-wide (610 meter), 21-mile-long (34 kilometer), segmented marsh and low ridge land form (roughly 5,000 acres [2000 ha]) would be constructed from the east bank of Bayou Terrebonne near Bush Canal to the west bank of Bayou Lafourche near the southern terminus of the hurricane protection levee. This landform would be constructed by depositing hydraulically dredged material and could resemble the long, linear, segmented dredge material disposal islands in Atchafalaya Bay. The nine major bayous, which connect the upper subbasin to the downstream lakes and bays, would remain open; among others, they include Grand Bayou Blue and Bayous Pointe Au Chien, Jean La Croix, Barre, and Tambour. The proposed land bridge alignment is in the upper salt Marsh zone, minimizes impacts to existing oyster leases, and avoids most of the oil and gas fields in the Timbalier Subbasin.

Multi-purpose operation of Houma Navigation Canal (HNC) Lock

The restoration feature involves the multi-purpose operation of the proposed HNC Lock, located at the southern end of the HNC. The Morganza to the Gulf Hurricane Protection Study includes construction of the lock, but does not include the multi-purpose operation of the lock. The objective of this feature is to make more efficient use of Atchafalaya River waters and sediment flow, as well as maintain salinity regimes favorable for area wetlands. The proposed structure would be operated to restrict saltwater intrusion and distribute freshwater and sediment during times of high Atchafalaya River flow. The current project is designed to limit saltwater intrusion, but with a minor modification would provide additional benefits to the wetlands by increasing retention time of Atchafalaya River water in the Terrebonne Basin wetlands. An increased retention time would provide additional sediment and nutrients to nourish the wetlands and would benefit the forested wetlands, and fresh, intermediate, and brackish marshes adjacent to the lock and canal; the Lake Boudreaux wetlands to the north; the Lake Mechant wetlands to the west; and the Grand Bayou wetlands to the east.

Penchant Basin Restoration

This restoration feature involves the implementation of the Penchant Basin Plan. This would increase the efficiency of Bayou Penchant to convey flows from the area wetlands as Atchafalaya River stages fall after spring floods, and reduce excessive water levels in the upper Penchant Subbasin. Increased outlet capacities would utilize flow, increasing circulation and retention in tidal wetlands below the large fresh floating marsh area.

Rebuild Historic Reefs - rebuild historic barrier between Point Au Fer and Eugene Island and construct segmented reef/breakwater/jetty along the historic Point Au Fer Barrier Reef from Eugene Island extending towards Marsh Island to the west

This restoration feature would increase the rate of Atchafalaya Delta growth and would increase the Atchafalaya River influence in Atchafalaya Bay, Point Au Fer Island, and Four League Bay by rebuilding the historic barrier between Point Au Fer and Eugene Island. This barrier would separate these areas from the gulf following the historic Point Au Fer reef alignment. The barrier could be a reef, a barrier island, an intertidal spit, or a segmented breakwater. The barrier would increase delta development by reducing the erosive wave effects. Atchafalaya River freshwater influence would be increased in the interior areas of the Atchafalaya Basin. Constructing a segmented reef/breakwater/jetty along the historic Point Au Fer barrier reef from Eugene Island extending towards Marsh Island to the west would produce similar beneficial effects in the western portion of Atchafalaya Bay. The barrier would join the Bayou Sale natural levee feature.

Acadiana Bays Estuarine Restoration

This restoration feature provides for rebuilding historic Point Chevreuil Reef toward Marsh Island, and rehabilitating the Bayou Sale natural levee between Point Chevreuil and the gulf. The natural levee would be rebuilt in the form of a shallow sub-aqueous platform, small islands, and/or reefs. The historic shell reefs were removed by shell dredging. This feature was designed to help restore historic hydrologic conditions in the Teche/Vermilion Basin.

Rehabilitate northern shorelines of Terrebonne/Timbalier Bays

This feature provides for the rehabilitation of the northern shorelines of Terrebonne/Timbalier Bays with a segmented breakwater from the Seabreeze area to the Little Lake area. This feature would rebuild and maintain the historic shoreline integrity around Terrebonne and Timbalier Bays by constructing segmented barriers along the west side of Terrebonne Bay, across the historic shoreline alignment along the northern sides of both bays, and along the eastern side of Timbalier Bay.

Relocate the Atchafalaya Navigation Channel

This restoration feature consists of relocating the Atchafalaya Navigation Channel. The navigation channel route through the delta has been identified as the greatest impediment to the delta's growth. By rerouting the channel between the delta lobes, and by using a passive hydraulic structure at the point of departure in the Lower Atchafalaya River, river sediment would be used more efficiently in the growing delta.

Terrebonne Basin barrier shoreline restoration

This feature originally considered restoration elements for all the major reaches of the Terrebonne barrier-shoreline chain. However, for inclusion in the near-term plan some consideration to the most critically needed elements of the chain. This restoration feature provides for the restoration of the Timbalier and Isles Dernieres barrier island chains. This would simulate historical conditions by reducing the current number of breaches, enlarging (width and dune crest) of the Isles Dernieres (East Island, Trinity Island, and Whiskey Island), Timbalier Island, and East Timbalier Island.

Stabilize banks of Southwest Pass

This restoration feature would maintain the integrity of Southwest Pass channel connecting southwestern Vermilion Bay with the Gulf of Mexico by protecting its bay and gulf shorelines. This feature would involve the construction of a dike and armoring of the banks of the pass to maintain the existing pass dimensions.

Gulf shoreline stabilization at Point Au Fer Island

This feature provides for stabilizing of the gulf shoreline of Point Au Fer Island. The purpose is to prevent direct connections from forming between the gulf and interior water bodies as the barrier island is eroded. In addition to gulf shoreline protection, this feature would prevent the fresher bay side water circulation patterns from being influenced directly by the gulf, thus protecting the estuarine habitat, which has higher quality wetland habitats, from conversion to marine habitat.

Alternative operational schemes of Old River Control Structure (ORCS)

This feature would evaluate alternative ORCS operational schemes with a goal of increasing the sediment load transported by the Atchafalaya River for the purpose of benefiting coastal wetlands. Detailed studies of this feature would determine: impacts (beneficial and adverse) to the interior of the Atchafalaya Basin; the degree to which flow and sediment redistributions would be required; and the increased costs of maintaining the flood control, navigation, and environmental features along the Lower Mississippi, Red, and Atchafalaya Rivers.

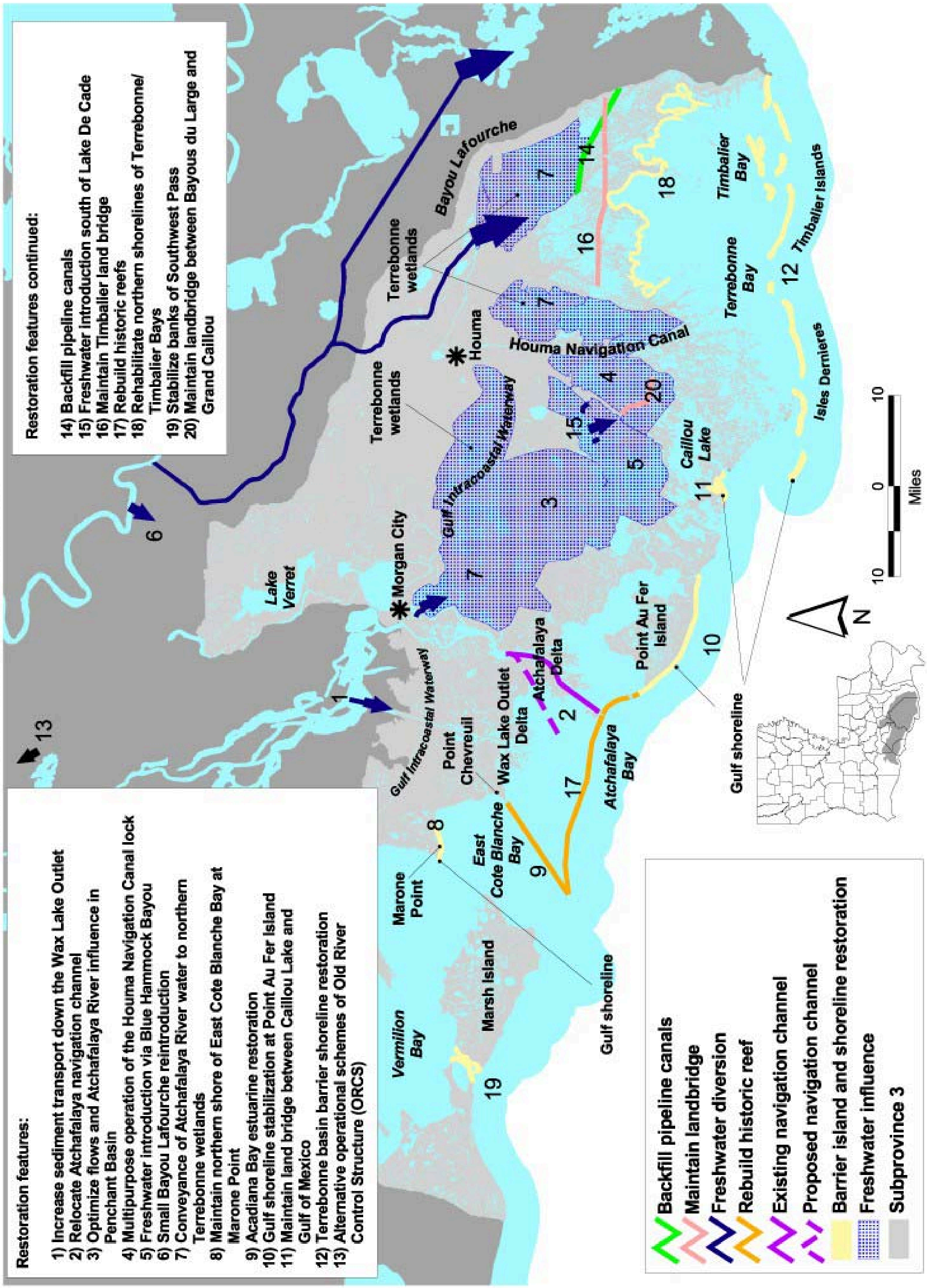


Figure 2-8. Subprovince 3 Restoration Features Identified in the Final Array of Coast Wide Frameworks.

2.3.6.1.4 *Subprovince 4 feature descriptions*

Black Bayou bypass culverts

This restoration feature involves the replacement of the Calcasieu Lock in the GIWW west of the Hwy 384 Bridge and uses the old lock for freshwater introduction to the upper Calcasieu estuary from the Mermentau Basin. This feature also incorporates freshwater introduction via the Black Bayou Culverts feature at the intersection of Black Bayou and Hwy 384.

Calcasieu Ship Channel Beneficial Use

This feature capitalizes on the existing navigation maintenance activity by expanding beneficial use of dredged material from the Calcasieu Ship Channel. It accomplishes this by extending the application of material dredged from the channel for routine maintenance beyond the normal standard. Average annual maintenance dredging volume is approximately 4 million cubic yards (3.1 million cubic meters). The expanded use of this material would result in wetland creation over 50 years of application.

Chenier Plain freshwater management and allocation reassessment

This restoration opportunity requires detailed investigations involving water allocation needs and trade-off analysis in the eastern Chenier Plain, including the Teche/Vermilion Basin, to provide for wetland restoration and support continued agriculture and navigation in the region. A series of navigation and salinity control structures are currently authorized and operated in the eastern portion of the Chenier Plain. These structures maintain a freshwater source for agricultural applications and prevention of salinity intrusion in the area. Tidal stages have predominantly exceeded stages within the managed area creating a ponding issue for the fresh and intermediate marshes in the area. In addition, the natural ridges that define this area continue to be impacted by erosion, further threatening the ability for continued management and sustainability of the interior marshes. The study would address water management and allocation issues including salinity control, drainage, and fisheries accessibility.

Dedicated dredging for marsh restoration

This restoration feature would apply dredged material from offshore sources beneficially to restore subsided wetlands on Sabine National Wildlife Refuge (NWR) and adjacent properties. Locations for marsh restoration would be north and northwest of Browns Lake on Sabine NWR. Average open water depth is 1.5 to 2 feet (0.4 to 0.6 meters) deep.

East Sabine Lake hydrologic restoration

This restoration feature involves restoration of East Sabine Lake between Sabine Lake and Sabine NWR Pool 3. This feature would include salinity control structures at Willow Bayou, Three Bayou, Greens Bayou, and Right Prong of Black Bayou. Sediment terracing would also be used in shallow open water areas along with shoreline protection along Sabine Lake and some smaller structures.

Freshwater introduction at Highway 82

This restoration feature provides for drainage of “excess” freshwater from the Mermentau Basin Lakes Subbasin across Hwy 82 to the Chenier Subbasin at the Highway 82 area between Rollover Bayou and Superior Canal to the eastern portion of Rockefeller Refuge. This introduction would involve the replacement or modification of culverts under Hwy 82. The objective of this feature is to relieve elevated stages in the northern area and provide freshwater input to the brackish and intermediate marshes to the south. This feature is intended to work in concert with four other restoration feature located along the Hwy 82 alignment.

Freshwater introduction at Little Pecan Bayou

This restoration feature provides for drainage of “excess” freshwater from the Mermentau Basin Lake Subbasin across Hwy 82 to the Chenier Subbasin west of Rockefeller Refuge at the Thibodeaux Bridge. This introduction would involve the replacement or modification of culverts under Hwy 82. The objective of this feature is to relieve elevated stages in the northern area and provide freshwater input to the brackish and intermediate marshes to the south. This feature is intended to work in concert with four other restoration feature located along the Hwy 82 alignment.

Freshwater introduction at Pecan Island

This restoration feature provides for drainage of “excess” freshwater from the Mermentau Basin Lake Subbasin across Hwy 82 near Pecan Island to the Chenier Subbasin. This introduction would involve the replacement or modification of culverts under Hwy 82. The objective of this feature is to relieve elevated stages in the northern area and provide freshwater input to the brackish and intermediate marshes to the south. This feature is intended to work in concert with four other restoration feature located along the Hwy 82 alignment.

Freshwater introduction at Rollover Bayou

This restoration feature provides for drainage of “excess” freshwater from the Mermentau Basin Lake Subbasin across Hwy 82 at Rollover Bayou to the Chenier Subbasin. This introduction would involve the replacement or modification of culverts under Hwy 82. The objective of this feature is to relieve elevated stages in the northern area and provide freshwater input to the brackish and intermediate marshes to the south. This feature is intended to work in concert with four other restoration feature located along the Hwy 82 alignment.

Freshwater Introduction at South Grand Chenier

This restoration feature provides for drainage of “excess” freshwater from the Mermentau Basin Lakes Subbasin from the Mermentau River across Hwy 82 to the Chenier Subbasin Hog Bayou watershed. This introduction would involve the replacement or modification of culverts under Hwy 82. The objective of this feature is to relieve elevated stages in the northern area and provide freshwater input to the brackish and intermediate marshes to the south. This feature is intended to work in concert with four other restoration feature located along the Hwy 82 alignment.

Stabilize Gulf shoreline near Rockefeller Refuge

This restoration feature provides for gulf shoreline stabilization from Mermentau Ship Channel to near Rollover Bayou east of Rockefeller Refuge. Stabilization methods include rock foreshore dikes, offshore reefs, or segmented breakwaters, similar to Holly Beach breakwaters, placed closer to shore and with narrower gaps. The objective of this feature is the prevention of shoreline breaching into the landward brackish and intermediate marshes.

Modify existing Cameron-Creole watershed structures

The Cameron-Creole watershed feature, constructed in 1989, consists of 5 large concrete water control structures and a 16 mile-long levee along the shoreline of Calcasieu Lake. Three of the five structures (Grand Bayou, Bois Connine Bayou, and Lambert Bayou) are adjustable structures with slide gates and the remaining two (Mangrove Bayou and No Name Bayou) are fixed crest weir structures. The fixed crest weir sill heights may be set too high. This higher setting could be contributing to the impoundment problem within Cameron-Creole marshes adjacent to those structures. If the weir sills for these two structures could be modified to lower weir crests, reduced impoundment, greater water flow, and increased fisheries access (above that afforded by the vertical fish slots already present in the structures) would occur independent of salinity control at Calcasieu Pass.

New Lock at the GIWW

This feature consists of a new lock at the GIWW east of Alkali Ditch with dimensions of 75 to 110 feet (23 to 34 meters) wide by 15 feet (4.6 meters) deep. This restoration feature would limit the exchange of water between the Sabine River and the GIWW eastward to the Calcasieu River. The existing circulation pattern provides a mechanism for the intrusion of higher salinity waters transmitted by the deeper navigation channels in each of the rivers to reach the interior marshes. The objective of the feature is the reduction of circulation of higher salinity water through the Calcasieu-Sabine sub-basin, thereby reducing future wetlands loss.

Salinity control at Alkali Ditch

This restoration feature provides salinity control at the Alkali Ditch, northwest of Hackberry at the GIWW, with a gated structure or rock weir with barge bay. The existing dimensions of the feature are approximately 150 to 200 feet (45 to 60 meters) wide by 8 to10 feet (2.4 to 3 meters) deep; the structure or weir with approximate dimensions 70 feet wide (21 meters) by 8 feet (2.4 meters) deep. The objective of this feature is to regulate saltwater intrusion in order to stabilize the brackish and intermediate marshes in the area and reduce future loss.

Salinity control at Black Bayou

This restoration feature calls for a salinity control structure with boat bay at the mouth of Black Bayou (either a gated structure or a rock weir), located at the intersection of Black Bayou and the northeastern shoreline of Sabine Lake. The existing bayou dimensions are 150 to 200 feet (45 to 60 meters) wide by 10 feet (3 meters) deep. The objective of this feature is to regulate saltwater intrusion in order to stabilize the brackish and intermediate marshes in the area and reduce future loss.

Salinity control at Black Lake Bayou

This restoration feature calls for salinity control in Long Point Bayou with a gated structure or rock weir located in Long Point Bayou north of Sabine NWR near Hwy 27, west of the Calcasieu Ship Channel. The existing dimensions are 40 feet wide (12 meters) by 5 feet (1.5 meters) deep. The structure's approximate dimensions are 10 to 15 feet (3 to 4.5 meters) wide by 4 feet (1.2 meters) deep boat bay. The objective of this feature is to regulate saltwater intrusion in order to stabilize the brackish and intermediate marshes in the area and reduce future loss.

Salinity control at Highway 82 Causeway

This restoration feature provides for a rock weir at Hwy 82 Causeway located in the southern portion of Sabine Lake north of Sabine Pass and the Sabine-Neches Waterway. Existing dimensions of the facility equal approximately 3,400 feet wide by approximately 4 feet deep, except at the approximate 10 feet (3 meters) deep center channel. The objective of this feature is to regulate saltwater intrusion in order to stabilize the brackish and intermediate marshes in the area and reduce future loss.

Salinity control at Long Point Bayou

This restoration feature provides for salinity control in Long Point Bayou with a gated structure or rock weir located in Long Point Bayou north of Sabine NWR near Hwy 27, west of the Calcasieu Ship Channel. The existing dimensions are 40 feet wide by 5 feet deep. The structure's approximate dimensions are 10 to 15 feet (3 to 4.5 meters) wide by 4 feet (1.2 meters) deep boat bay. The objective of this feature is to regulate saltwater intrusion in order to stabilize the brackish and intermediate marshes in the area and reduce future loss.

Salinity control at Oyster Bayou

This restoration feature provides for salinity control in Oyster Bayou with a gated structure or rock weir. The location in Oyster Bayou is about 1 mile west of the Calcasieu Ship Channel, which is 100 to 150 feet wide by 10 feet deep; with an approximately 15 to 20 foot (4.5 to 6 meters) wide by 4 foot (1.2 meters) deep boat bay. The objective of this feature is to regulate saltwater intrusion in order to stabilize the brackish and intermediate marshes in the area and reduce future loss.

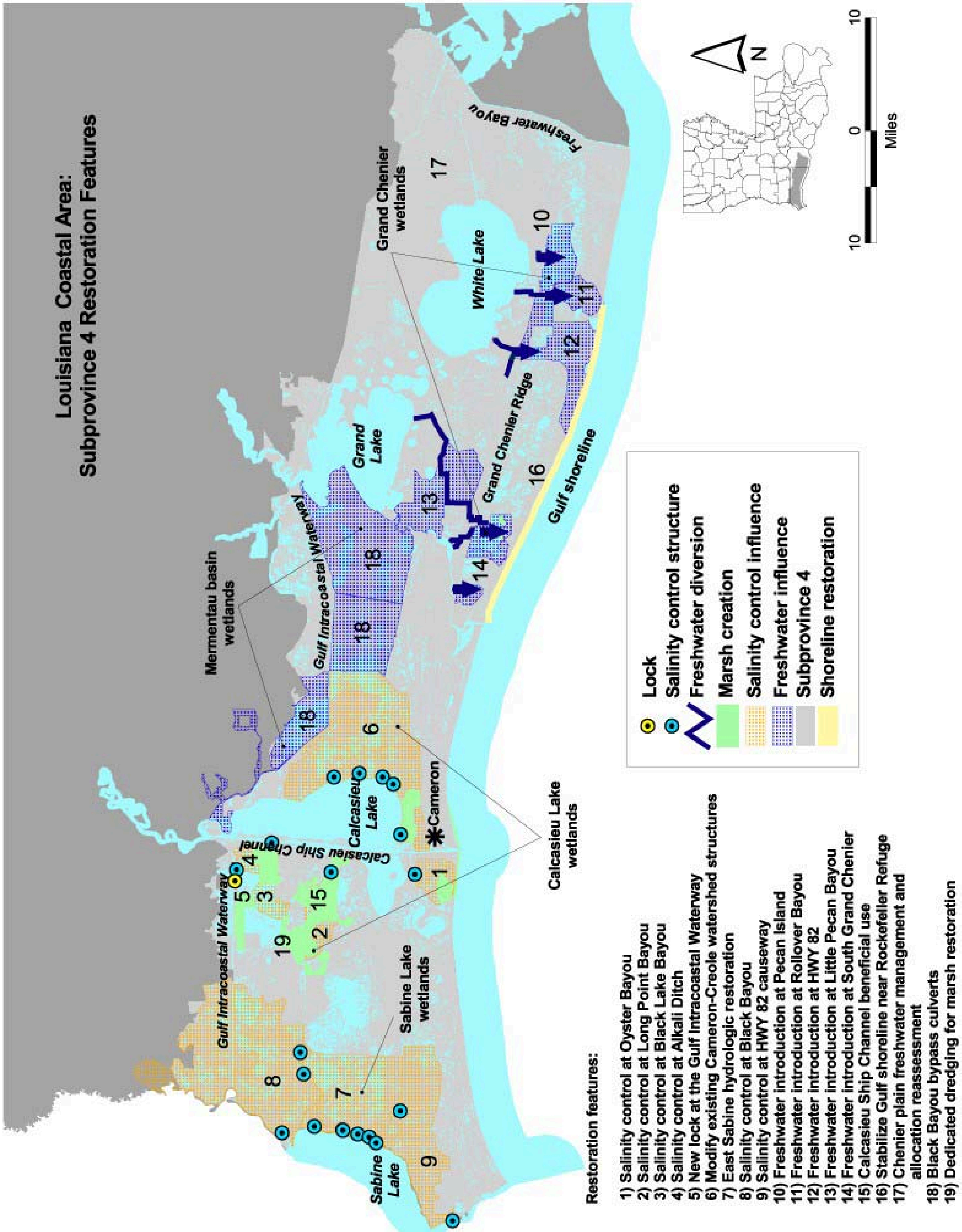


Figure 2-9. Subprovince 4 Restoration Features Identified in the Final Array of Coast Wide Frameworks.

2.3.7 Development of Sorting and Critical Needs Criteria

The PDT determined that use of initial sorting criteria and follow-on critical needs criteria-based evaluations was an appropriate method to determine which of the 79 features would best meet near-term requirements. Criteria were developed to identify which restoration features would be placed into the various component categories described in Section 3.3.6. In addition, the criteria helped identify the ability of each restoration feature to address critical needs.

The initial step in identifying these criteria was the gathering of input by the PDT. The Vertical Team, Framework Development Team, and the PDT developed a methodology to: 1) sort the restoration features into the component categories of the alternative LCA Plans; and 2) identify the relative value of a restoration feature in addressing critical ecologic needs in the coastal landscape. The criteria were designated as either “sorting” or “critical needs” criteria. The PDT designated three sorting criteria, and four critical needs criteria.

2.3.7.1 <u>Sorting criteria</u>

2.3.7.1.1 *Sorting Criterion #1 - Engineering and design complete and construction started within 5 to 10 years*

A restoration feature would meet this criterion if, over the next 5 to 10 years:

- Required feasibility-level decision documents could be completed;
- Necessary NEPA documentation could be completed;
- Pre-construction engineering & design (PED) could be completed; and
- Construction authorization could be obtained and construction could be initiated.

If a restoration feature did not meet this criterion, it was not viewed as a potential near-term restoration opportunity, but rather a potential candidate for large-scale and long-range study.

2.3.7.1.2 *Sorting Criterion #2 - Based upon sufficient scientific and engineering understanding of processes*

A restoration feature would successfully meet this criterion if it contained:

- Opportunities for which there is currently a sound understanding based in science and technology; and
- Science and engineering principles that have been applied within Louisiana and successfully achieved a beneficial ecosystem response.

Features that did not meet this criterion were not considered as potential near-term restoration opportunities. Instead, the scientific and/or engineering uncertainties associated with these restoration features provided a basis for the feature to be a potential candidate for a demonstration project.

2.3.7.1.3 *Sorting Criterion #3 - Implementation is independent; does not require another restoration feature to be implemented first*

If a feature was not deemed to be independent, other features that potentially had overlapping or duplicative effects were identified, and the interdependent features were combined. This combination of features was then reassessed to determine if, as a composite, the group of features met the initial two sorting criteria and classified appropriately. The intent of this criterion was to ensure that those features with overlapping hydrologic or ecologic influence area were considered simultaneously in their design development. This criterion was meant to apply specifically to, but not be limited to, those features that would be implemented in the near-term restoration effort. The realization of individual feature benefits is not dependent on implementation of all features. Once they have been synergistically designed, each feature will be of an appropriate scale to operate independently without being redundant with other features within the influence area.

The sorting criteria were applied sequentially. In other words, if a feature failed to meet criterion #2, then it was not reviewed to assess whether it met criterion #3. The process of applying these sorting criteria is represented in the flow diagram in **figure 2-10**.

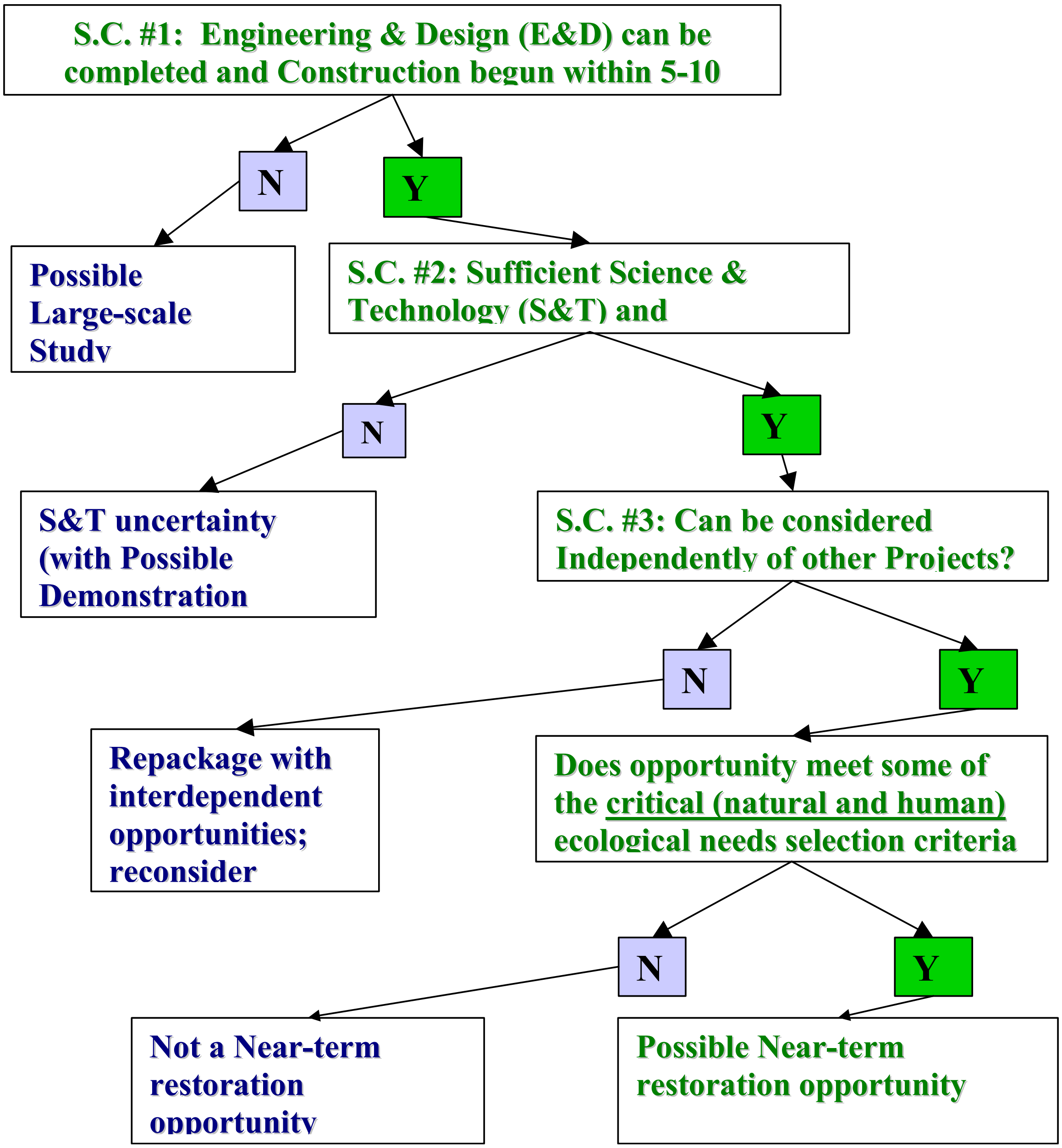


Figure 2-10. LCA Sorting Process Flow Diagram.

2.3.7.2 <u>Critical needs criteria</u>

If a restoration feature met all of the sorting criteria, it was then assessed against the critical needs criteria. The application of the criteria was done in an annotated manner so that the reasoning for applicability of each feature versus the criteria could be readily assessed. This approach allowed the PDT to make relative comparisons of different features based on common criteria and fine tune the overall value of features in addressing the critical ecologic and human needs of the system. The following criteria were applied to potential near-term course of action features as defined.

2.3.7.2.1 *Critical Needs Criterion #1 - Prevents future land loss where predicted to occur*

One of the most fundamental drivers of ecosystem degradation in coastal Louisiana has been the conversion of land (mostly emergent vegetated wetland habitat) to open water. One of the most fundamental critical needs is to stem this loss. Thus, the projection of the future condition of the ecosystem must be based upon the determination of future patterns of land and water. Future patterns of land loss were based on the USGS open file report 03-334 “Historical and Predicted Coastal Louisiana Land Changes: 1978-2050” (appendix B HISTORIC AND PROJECTED COASTAL LOUISIANA LAND CHANGES: 1978-2050). This also applies to future predicted conversion of cypress swamp in areas with existing fragmenting marsh.

2.3.7.2.2 *Critical Needs Criterion #2 - (Sustainability) Restores fundamentally impaired (or mimics) deltaic function through river reintroductions*

This criterion refers to opportunities that would restore or mimic natural connections between the river and the basins (or estuaries), including distributary flows, crevasses, and over-bank flow. Mechanical marsh creation with river sediment was also viewed as mimicking the deltaic function of sediment introduction if supported by sustainable freshwater and nutrient reintroduction.

2.3.7.2.3 *Critical Needs Criterion #3 - (Sustainability) Restores or preserves endangered critical geomorphic structure*

This criterion identifies opportunities that would restore or maintain natural geomorphic structures such as barrier islands, distributary ridges, cheniers, land bridges, and beach and lake rims. These geomorphic structures are essential to maintaining the integrity of coastal ecosystems. Those structures that are endangered or “nearly lost” in the near-term are especially critical.

2.3.7.2.4 *Critical Needs Criterion #4 - Protects vital socioeconomic resources*

This criterion identifies proposed opportunities that would potentially protect vital local, regional, and national social, economic, and cultural resources. These resources include cultures, community, infrastructure, business and industry, and flood protection.

2.3.7.3 Application of the criteria

Following the identification of these restoration criteria and the method for their application, the PDT made an initial assessment of the 79 restoration features. This assessment indicated that the methodology could be applied effectively to identify potential alternative plans (**figure 2-10**).

During the week of April 19 to 23, 2004, a series of public scoping meetings were held across the LCA Study area. These meetings provided the public and stakeholder groups an opportunity to comment on the modification of the study and the specific criteria for identifying alternative LCA Plans. The participants were provided with an overview of the criteria and methodology, the written definition of each criterion's application, and a list of the 79 features. This information was also made available on the study's web site along with additional feature details. The meeting participants were encouraged to comment on and/or modify the criteria and methodology developed by the PDT, as well as to provide input on additional criteria that they considered appropriate. Finally, attendees were encouraged to take materials to other interested parties who were not able to attend or direct them to the study's web site to submit their comments.

The public input was compiled and used to make adjustments to the criteria or to the criteria's application to individual features. In addition, public input allowed the PDT to make final assessments of the appropriate components of the alternative LCA Plans.

2.4 SORTING CRITERIA APPLICATION RESULTS

During Phase VI, each of the 79 restoration features was analyzed through the three Sorting Criteria (**figure 2-10**) and four Critical Needs Criteria. These criteria were designed to determine whether or not a restoration feature should be incorporated as a near-term component in one or more of the LCA alternative plans. In addition, if it was determined that a feature was to be included in the near-term course of action, the criteria helped determine in which component category it would best fit. For example a restoration feature could represent a potential near-term critical restoration feature or a potential large-scale study for a promising restoration concept. Alternatively, an overarching scientific or technological uncertainty could be associated with a restoration feature that would first require the development and implementation of an appropriately scaled demonstration project prior to the implementation of the feature.

2.4.1 Results of Applying Sorting Criterion #1: Engineering and Design (E&D) can be Completed and Construction Started Within 5 to 10 Years

Application of Sorting Criterion #1 winnowed down the number of potential restoration features from 79 to 61. Those restoration features deemed too complex to have feasibility-level decision documents complete and construction begun within the next 5 to 10 years of plan implementation did not successfully pass through this sorting criterion and were instead considered for inclusion in the LCA Plan alternatives as potential large-scale studies. **Table 2-8** lists those restoration features that did not meet Sorting Criterion #1 and were, therefore eliminated from further consideration as near-term plan restoration features.

Table 2-8. Restoration Features Eliminated Using Sorting Criterion #1: Features Whose E&D Could Not be Completed and Construction Started Within the Next 5 to 10 Years.

Subprovince 1
- Medium diversion at Bonnet Carré Spillway
- Post authorization for the diversion of water through Inner Harbor Navigation Canal for increased influence into Central Wetlands
- Medium to large sediment diversion at American/California Bays
- Mississippi River Delta Management Study (Subprovinces 1 & 2)

Subprovince 2
- Medium diversion at Edgard with sediment enrichment
- Large diversion at Boothville with sediment enrichment
- Medium diversion at Fort Jackson - Alternative to Boothville diversion
- Large diversion at Fort Jackson with sediment enrichment - Alternative to Boothville diversion
- Medium diversion at Lac des Allemands with sediment enrichment
- Large diversion at Myrtle Grove with sediment enrichment
- Third Delta (Subprovinces 2 & 3)

Subprovince 3
- Relocate the Atchafalaya Navigation Channel
- Increase sediment transport down Wax Lake Outlet
- Alternative operational scheme of the Old River Control Structure (ORCS)
- Acadiana Bays Estuarine Restoration
- Rebuild historic reefs - Rebuild historic barrier between Point Au Fer and Eugene Island and construct segmented reef/breakwater/jetty along the historic Point Au Fer barrier reef from Eugene Island extending towards Marsh Island to the west

Subprovince 4
- Chenier Plain freshwater management and allocation reassessment*
    - Freshwater introduction at South Grand Chenier
    - Freshwater introduction at Pecan Island
    - Freshwater introduction at Rollover Bayou
    - Freshwater introduction at Highway 82
    - Freshwater introduction at Little Pecan Bayou
- New lock at the GIWW

** These features did not pass Sorting Criterion #3, were repackaged and are considered as a potential large-scale study within the Chenier Plain Freshwater Management and Allocation Study*

2.4.2 Results of Applying Sorting Criterion #2: Sufficient S&T and Engineering Understanding of Processes

Of the 61 features that met Sorting Criterion #1, 28 did not successfully meet Sorting Criterion #2 because they contained some form of scientific or technical uncertainty that would require resolution prior to their implementation. The various types of uncertainties are described in section 3.1 PLANNING CONSTRAINTS. These uncertainties may be resolved by the development and implementation of an appropriately scaled demonstration project (the specific features may suggest demonstration project locations). **Table 2-9** lists features that did not meet Sorting Criterion #2 and were, therefore eliminated from further consideration as near-term course of action restoration features.

Table 2-9. Restoration Features Eliminated Using Sorting Criterion #2: Features Having Major Uncertainties About Science and Technology and Engineering Understanding of Processes.

Subprovince 1

- Marsh nourishment on New Orleans East land bridge
- Sediment delivery via pipeline at La Branche wetlands
- Sediment delivery via pipeline at American/California Bays
- Sediment delivery via pipeline at Central Wetlands
- Sediment delivery via pipeline at Ft. St. Philip
- Sediment delivery via pipeline at Golden Triangle
- Sediment delivery via pipeline at Quarantine Bay
- Opportunistic use of Bonnet Carré Spillway

Subprovince 2

- Implement the LCA Barataria Basin Wetland Creation and Restoration Study
- Sediment delivery via pipeline at Bastian Bay/Buras
- Sediment delivery via pipeline at Empire
- Sediment delivery via pipeline at Main Pass (Head of Passes)

Subprovince 3

- Maintain land bridge between Bayous du Large and Grand Caillou
- Maintain Timbalier land bridge
- Backfill pipeline canals
- Freshwater introduction south of Lake De Cade
- Freshwater Introduction via Blue Hammock Bayou

Subprovince 4

- Salinity control at Alkali Ditch
- Salinity control at Highway 82 Causeway
- Salinity control at Oyster Bayou
- Salinity control at Long Point Bayou
- Salinity control at Black Lake Bayou
- Black Bayou Bypass culverts
- Dedicated dredging for marsh restoration
- Stabilize Gulf shoreline near Rockefeller Refuge
- Modify existing Cameron-Creole watershed structures
- East Sabine Lake hydrologic restoration
- Salinity control at Black Bayou

2.4.3 Results of Applying Sorting Criterion #3: Implementation is Independent; Does not Require Other Restoration Feature to be Implemented First

The remaining 33 features were next subjected to Sorting Criterion #3 to determine their independence from other restoration features. When running these remaining features through Sorting Criterion #3, 12 features were deemed to be independent (received a “Yes” for this criterion). These 12 features then proceeded to the Critical Needs Criteria evaluation. The 21 features that were determined to be interdependent (received a “No” for this criterion) were combined with other dependent features(s), as appropriate, to create “restoration opportunities”. The combined restoration opportunities were evaluated again using Sorting Criteria 1, 2, and 3. One of the restoration opportunities, Freshwater Reintroductions into Subprovince 4, (consisting of five features) failed to pass Sorting Criterion #1 and was reserved as a potential concept for large-scale studies and eliminated from consideration as a near-term restoration opportunity. The remaining 6 restoration opportunities (consisting of 16 features) passed both criteria 1 and 2 and were included for further consideration as near-term restoration opportunities. **Table 2-10** identifies the 12 restoration features and 6 combined restoration opportunities (made up of 16 restoration features) that were further evaluated using the Critical Needs Criteria. **Figure 2-11** provides a graphic representation of the Sorting Criteria Evaluation Process.

Table 2-10. Restoration Features and Restoration Opportunities that Passed Sorting Criteria 1 to 3.

Subprovince 1
- MRGO Environmental Restoration Features
- Maurepas Swamp Reintroductions Restoration Opportunity
  This restoration opportunity includes the following features:
  - Small diversion at Hope Canal
  - Small diversion at Convent / Blind River
  - Increase Amite River Diversion Canal influence by gapping banks
- Upper Breton Sound Reintroductions Restoration Opportunity
  This restoration opportunity includes the following features:
  - Modification of Caernarvon diversion
  - Medium diversion at White's Ditch
- Lower Breton Sound Reintroductions Restoration Opportunity
  This restoration opportunity includes the following features:
  - Rehabilitate Bayou Lamoque structure as a medium diversion
  - Medium diversion at American / California Bays
- Rehabilitate Violet Siphon for increased influence to Central Wetlands
- Medium diversion at Fort St. Philip

Subprovince 2
- Barataria Basin barrier shoreline restoration
- Mid-Barataria Basin Reintroductions Restoration Opportunity
  This restoration opportunity includes the following features:
  - Modification of Davis Pond diversion for increased sediment input
  - Medium diversion with dedicated dredging at Myrtle Grove
- Lac Des Allemands Area Reintroductions Restoration Opportunity
  This restoration opportunity includes the following features:
  - Small diversion at Lac Des Allemands
  - Small diversion at Donaldsonville
  - Small diversion at Pikes Peak
  - Small diversion at Edgard

Subprovince 3
- Small Bayou Lafourche reintroduction
- Terrebonne Marsh Restoration Opportunity
  This restoration opportunity includes the following features:
  - Optimize flows and Atchafalaya River influence in Penchant Basin
  - Multi-purpose operation of Houma Navigation Canal (HNC) Lock
  - Convey Atchafalaya River water to Terrebonne Marshes via a small diversion in the Avoca Island Levee, repairing eroding banks of the GIWW, and enlarging constrictions in the GIWW below Gibson and in Houma, and Grand Bayou conveyance channel construction / enlargement
- Terrebonne Basin barrier shoreline restoration
- Maintain land bridge between Caillou Lake and Gulf of Mexico
- Gulf shoreline stabilization at Point Au Fer Island
- Maintain northern shore of East Cote Blanche Bay at Point Marone
- Rehabilitate Northern Shorelines of Terrebonne / Timbalier Bays
- Stabilize banks of Southwest Pass

Subprovince 4
- Calcasieu Ship Channel Beneficial Use

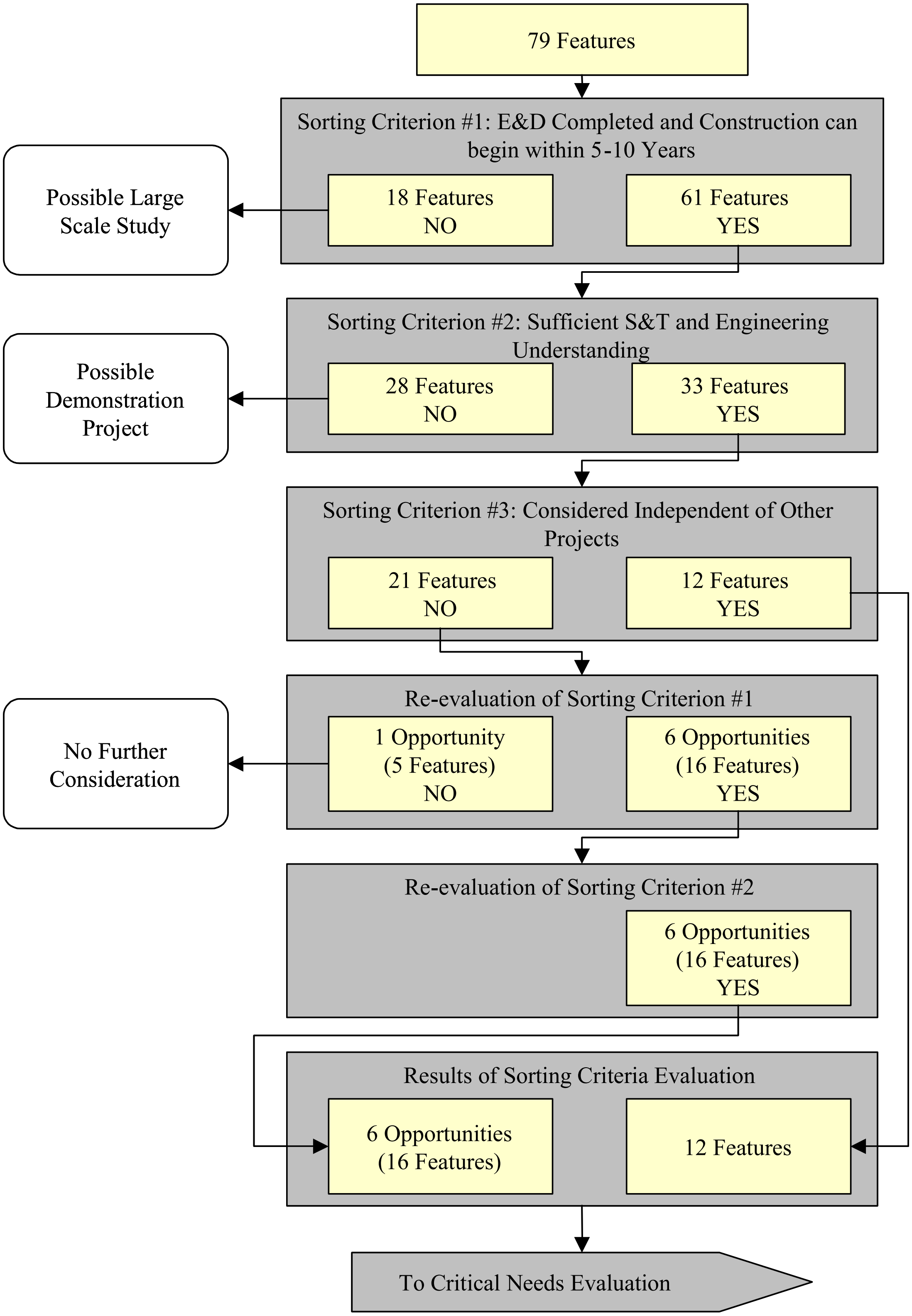


Figure 2-11. Application of Sorting Criteria to Restoration Features and Opportunities.

2.5 CRITICAL NEEDS CRITERIA APPLICATION RESULTS

Following the application of Sorting Criteria, the 12 restoration features and 6 restoration opportunities (made up of 16 restoration features) were further evaluated using the Critical Needs Criteria. Annotated comments were developed for each feature and opportunity to identify the particular Critical Need Criteria that a component met (or did not meet), as well as the relative ability of the feature or opportunity to address them. After evaluating the 12 features and 6 restoration opportunities using the Critical Needs Criteria, seven features and five restoration opportunities (made up of 14 restoration features) were determined to meet the Critical Needs Criteria. These features and opportunities were used to form the basis of the alternative near-term courses of action. Alternately, five features and one restoration opportunity (made up of two restoration features) did not meet the Critical Needs Criteria, and were not considered for inclusion in the near-term course of action. Below are the annotated comments of the results of the assessment of individual features and restoration opportunities following application of the four Critical Needs Criteria.

2.5.1 Features Having Major "Critical Needs Criteria" Value

2.5.1.1 Subprovince 1

MRGO Environmental Restoration Features

These features address Critical Needs Criteria 1, 3, and 4. Specifically, these features have the potential to: prevent predicted future land loss and restore previously degraded wetlands; stabilize and restore the endangered, critical lake rim geomorphic structure; and protect vital socioeconomic resources, such as developments located adjacent to the MRGO.

Maurepas Swamp Reintroductions Opportunity

The Maurepas Swamp Reintroduction Opportunity includes the following features:

- Small diversion at Hope Canal
- Small diversion at Convent / Blind River
- Increase Amite River Diversion Canal influence by gapping banks

This near-term restoration opportunity evaluates several features that have the potential to address Critical Needs Criteria 1, 2, and 4. Specifically, this opportunity has the potential to: prevent future cypress swamp degradation and transition currently predicted to occur; restore the deltaic process impaired by levee and dredged material bank construction; and protect vital socioeconomic and public resources, such as the growing eco-tourism industry resident in the Maurepas Swamp and the Maurepas Wildlife Management Area.

Upper Breton Sound Reintroductions Opportunity

The Upper Breton Sound Reintroduction Opportunity includes the following features:

- Modification of Caernarvon diversion
- Medium diversion at White's Ditch

This near-term restoration opportunity evaluates several features that have the potential to address Critical Needs Criteria 2 and 4. Specifically, this opportunity has the potential to restore the deltaic process impaired by levee construction at locations where historic crevassing has occurred and protect vital socioeconomic resources located in areas along the east bank of the Mississippi River in Plaquemines Parish within hurricane flood protection levees. This opportunity also includes features that capitalize on existing structures, such as the Caernarvon diversion.

2.5.1.2 Subprovince 2

Barataria Basin Barrier Shoreline Restoration

This restoration feature has multiple components, some of which have potential to address Critical Needs Criteria 1, 3, and 4. This near-term critical feature has been defined as restoration of the Caminada Headland and Shell Island reaches. These elements of the Barataria barrier-shoreline directly meet specific critical need criteria internal and external to the feature footprint. The feature has the potential to: preventing future land loss where currently predicted to occur; restoring immediately endangered, critical geomorphic structure at the gulfward boundary of the Barataria system; and providing immediate protection of vital socioeconomic resources, such as oil and gas infrastructure located on the leeward side of these islands. In addition the elements of this feature are related to the support and function of all the other elements of the Barataria barrier-shoreline chain. All other elements of this barrier-shoreline are currently being considered for restoration action under other programs. However, this feature does entail some aspects of technical uncertainty in the availability and quality of source material, delivery material by pipeline, and durability.

Mid-Barataria Basin Reintroductions Opportunity

The Mid-Barataria Basin Reintroduction Opportunity includes the following features:

- Modification of Davis Pond diversion
- Medium diversion with dedicated dredging at Myrtle Grove

This near-term restoration opportunity evaluates several features that have the potential to address Critical Needs Criteria 1, 2, and 4. Specifically, this opportunity has the potential to: prevent future land loss where currently predicted to occur; restore the deltaic process impaired by the construction of levees at locations where historic crevassing has occurred, as well as improve water quality; and protect vital socioeconomic resources located in the central and upper portions of the Barataria Basin. This opportunity would also capitalize on the existing Davis Pond diversion structure.

Lac des Allemands Area Reintroductions Opportunity

The Lac des Allemands Area Reintroductions Opportunity includes the following features:

- Small diversion at Lac Des Allemands
- Small diversion at Donaldsonville
- Small diversion at Pikes Peak
- Small diversion at Edgard

This near-term restoration opportunity evaluates several features that have the potential to address Critical Needs Criteria 1, 2, and 4. Specifically, this opportunity has the potential to: prevent greater future land loss where currently predicted to occur; restore the deltaic process impaired by levee construction in areas where historic crevassing has occurred, prevent swamp degradation and stagnation; and protect vital socioeconomic resources such as the eco-tourism industry and residents in the upper Barataria Basin.

2.5.1.3 Subprovince 3

Small Bayou Lafourche Reintroduction

This feature would reintroduce flow from the Mississippi River into Bayou Lafourche and addresses Critical Needs Criteria 1, 2, and 4. Specifically, this feature has the potential to: prevent future land loss where predicted to occur; restore a fundamentally impaired deltaic process by reintroducing water to a historic distributary of the Mississippi; and protect vital community and socioeconomic resources by supplementing channel flow and stabilizing water quality.

Terrebonne Basin Barrier Shoreline Restoration

This near-term critical feature has been defined as restoration of the Isle Dernieres and East Timbalier reaches of the Terrebonne barrier-shoreline chain. All other elements of this barrier-shoreline are currently being considered for restoration action under other programs. This restoration feature has multiple components, some of which have potential to address Critical Needs Criteria 1, 3, and 4. Specifically, this feature has the potential to: prevent future barrier island losses where predicted to occur; restore endangered, critical geomorphic structure; and protect vital socioeconomic resources such as oil and gas infrastructure and fisheries. However, this feature entails some aspects of technical uncertainty in the availability and quality of source material, delivery of material by pipeline, and durability.

Maintain Land Bridge Between Caillou Lake and Gulf of Mexico

This restoration feature addresses Critical Needs Criteria 1 and 3. This feature would stem shoreline retreat and prevent further breaches that have allowed increased water exchange between the gulf and the interior water bodies (between Bay Junop and Caillou Lake). Prevention of increased marine influence would reduce interior wetland loss as well as preserve the potential for long-range restoration. Closure of newly opened channels would restore historic cross-sections of exchange points, would reduce marine influences in interior areas, and allow increased freshwater influence from Four League Bay to benefit area marshes.

Gulf Shoreline Stabilization at Point Au Fer Island

This feature addresses Critical Needs Criteria 1, 3, and 4. Specifically, this feature has the potential to: prevent future shoreline retreat, where predicted to occur; restore endangered, critical geomorphic structure by stabilizing the island shoreline; and protect vital community and socioeconomic resources.

Terrebonne Marsh Restoration Opportunity

The Terrebonne Marsh Restoration Opportunity includes the following features:

- Optimize flows and Atchafalaya River influence in Penchant Basin
- Multi-purpose operation of Houma Navigation Canal (HNC) Lock
- Convey Atchafalaya River water to Terrebonne Marshes via a small diversion in the Avoca Island levee, repairing eroding banks of the GIWW, and enlarging constrictions in the GIWW below Gibson and in Houma, and Grand Bayou conveyance channel construction/enlargement

This near-term restoration opportunity evaluates several features that have the potential to address Critical Needs Criteria 1, 2, and 4. Specifically, this opportunity has the potential to: prevent future land loss where predicted to occur; restore fundamentally impaired deltaic processes through the re-introduction of Atchafalaya River water; and protect vital community and socioeconomic resources in the area, such as waterborne commerce and oil and gas infrastructure.

2.5.1.4 Subprovince 4

Calcasieu Ship Channel Beneficial Use

This feature addresses Critical Needs Criteria 1 and 4. Specifically, this feature has the potential to prevent future land loss where predicted to occur and protect vital community and socioeconomic resources of agricultural land use and oil and gas infrastructure. It also capitalizes on the existing navigation maintenance activity.

2.5.2 Features and Opportunities Having Limited or No "Critical Needs Criteria" Value

2.5.2.1 Subprovince 1

Lower Breton Sound Reintroductions Opportunity

The Lower Breton Sound Reintroductions Opportunity includes the following features:

- Rehabilitate Bayou Lamoque structure as a medium diversion
- Medium diversion at American/California Bays

This near-term restoration opportunity evaluates two features that have the potential to address Critical Needs Criteria 2 and 4. This opportunity also includes features that capitalize on existing structures, such as the Bayou Lamoque diversion. While this opportunity has some limited potential to restore the deltaic process in locations where historic crevassing has occurred, the proposed scale does not afford an appreciable influence on the critical need in the area. As a result, this opportunity was not included in any alternative plans.

Rehabilitate Violet Siphon for Increased Influence into Central Wetlands

This feature has some effectiveness meeting Critical Needs Criteria 1 and 2. However, the existing structure has currently been rehabilitated and is operating to capacity on a regulated schedule. Therefore, this feature was not included in any alternative plans.

Medium Diversion at Fort St. Philip

This feature has limited impact meeting Critical Needs Criterion #2. Specifically, this feature appears to have some limited potential to restore deltaic process in the area. However, the major ecologic need in the area is the introduction of large volumes of sediment. The assessment of this feature was that it fell low in the priority of possible critical near-term actions and was therefore not included in any alternative plans.

2.5.2.2 Subprovince 3

Maintain Northern Shore of East Cote Blanche Bay at Point Marone

This feature addresses Critical Needs Criteria 1 and 3 to a minor extent. Specifically, this feature has the potential to prevent some limited future shoreline retreat where predicted to occur and restore some geomorphic structure by stabilizing a small portion of this bay shoreline. The assessment of this feature was that it fell low in the priority of possible critical near-term actions and was therefore not included in any alternative plans.

Rehabilitate Northern Shorelines of Terrebonne/Timbalier Bays

This feature addresses Critical Needs Criteria 1 and 4. Specifically, this feature has the potential to prevent future shoreline retreat where predicted to occur and protect vital community and socioeconomic resources. This feature potentially duplicates the effects of the Terrebonne Basin Barrier-shoreline Restoration feature. The assessment of this feature is that in the near-term the immediate stabilization of the existing barrier-shoreline features is a more effective option. While this feature could be investigated in conjunction with the barrier-shoreline feature, it was not included in any alternative plans.

Stabilize Banks of Southwest Pass

Consideration of critical near-term criteria applied to assess the extent to which critical ecologic needs in the coast would be addressed, this feature was deemed less effective. While qualifying, with some effect relative to critical needs criteria, this feature does not appear to produce appreciable enough changes in the ecosystem to include in any alternative plans. The feature may be further investigated in conjunction with the large-scale Acadiana Bays Estuarine Restoration Study.

2.6 ALTERNATIVE PLAN EVALUATION RESULTS

As detailed previously, application of the three sorting criteria and four critical needs criteria was the basis for development of alternative plans composed of near-term critical features, candidate large-scale studies, and candidate science and technology demonstration projects. The sorting criteria application that determined what were the possible near-term critical features among the 79 initial features was considered fixed. The best opportunity to develop alternative plans resided in the application of the critical needs criteria to determine the near-term critical features. While each of the critical needs criteria were supporting and complimentary, it was possible to discern alternative combinations of near-term critical features by applying the criteria individually or in varying combinations.

Alternative plans, which include differing restoration features and restoration opportunities, were developed for evaluation based on the ability of the alternative to meet one or more of the Critical Needs Criteria. Alternatives represent combinations of specific features or actions that are capable of achieving the identified planning objectives through appreciably different ecologic modifications or technical methods and thereby represent clearly different options for achieving restoration. **Table 2-11** presents the 15 Alternative Plans (plus the No Action Alternative), provides the corresponding plan name (represented by the letters A – O), and identifies which Critical Needs Criterion/Criteria each specific alternative strived to meet. For example, Alternative Plans A, B, D, and H all focus on meeting one of the Critical Needs Criteria (1 through 4 respectively). The remaining 11 Alternative Plans were formulated to include all remaining possible mathematical combinations of the 4 Critical Needs Criteria.

Table 2-11. Possible Alternative Plan Combinations Based on the Critical Needs Criteria.

Alternative Plan	Criterion 1 (Prevent Future Land Loss)	Criterion 2 (Riverine Reintroductions)	Criterion 3 (Restore Geomorphic Structure)	Criterion 4 (Protects Vital community & socioeconomic resources)
A	X			
B		X		
C	X	X		
D			X	
E	X		X	
F	X	X	X	
G		X	X	
H				X
I	X			X
J		X		X
K	X	X		X
L	X		X	X
M			X	X
N	X	X	X	X
O		X	X	X
P (No Action)				

Using the annotated comments that resulted from the Critical Needs Criteria evaluation process, specifically the consensus opinion on which Critical Needs Criteria a restoration feature or opportunity best addresses, the PDT populated each of the 15 alternative plans with the restoration features and opportunities that successfully passed through both Screening and Critical Needs Criteria. For example, Alternative A includes all viable restoration features and opportunities that address Critical Needs Criteria 1 (preventing future land loss). Continuing the example, Alternative C is comprised of all viable restoration features and opportunities that address both Critical Needs Criteria 1 and 2 (prevent future land loss and utilizing riverine reintroductions). A summary of the restoration features and restoration opportunities included in each of the 15 alternative plans is detailed in **table 2-12**.

Table 2-12. Alternative Plan Make-up.

		Alternative Plans														
		A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**
Restoration Feature or Opportunity	MRGO Environmental Restoration Features	X		X	X	X	X	X	X	X	X	X	X	X	X	X
	Maurepas Swamp Reintroduction Opportunities	X	X	X		X	X	X	X	X	X	X	X	X	X	X
	Barataria Basin Barrier Shoreline Restoration	X		X	X	X	X	X	X	X	X	X	X	X	X	X
	Small Bayou Lafourche Reintroduction	X	X	X		X	X	X	X	X	X	X	X	X	X	X
	Mid-Barataria Basin Reintroduction Opportunity	X	X	X		X	X	X	X	X	X	X	X	X	X	X
	Upper Breton Sound Reintroduction Opportunity		X	X			X	X	X	X	X	X	X	X	X	X
	Calcasieu Ship Channel Beneficial Use	X		X	X	X	X	X		X		X	X	X	X	X
	Terrebonne Marsh Restoration Opportunity	X	X	X		X	X	X	X	X	X	X	X	X	X	X
	Terrebonne Basin Barrier Shoreline Restoration	X		X	X	X	X	X	X	X	X	X	X	X	X	X
	Maintain Land Bridge Between Caillou Lake and Gulf of Mexico	X		X	X	X	X	X		X		X	X	X	X	X
	Gulf Shoreline Stabilization at Point Au Fer Island	X		X	X	X	X	X	X	X	X	X	X	X	X	X
	Las des Allemands Area Reintroductions Opportunity	X	X	X		X	X	X		X	X	X	X		X	X

Evaluation of the 15 alternatives was based on the identification of appreciably different alternative plans to meet the study objectives and Critical Needs Criteria. As **table 2-12** clearly shows, all of the restoration features and measures available to make up the suite of alternative plans were found in more than one Alternative Plan. This is due to the fact that all available restoration features and measures met multiple Critical Needs Criteria. For example, the MRGO Environmental Restoration Feature met Critical Needs Criteria 1, 3, and 4. Because of this, the process of identifying and delineating appreciably different alternative plans was one in which the 15 alternative plans underwent intense scrutiny. A discussion of the composition of, and similarities and differences between, alternative plans follows.

2.6.1 Alternative Plans Designed to Meet Only 1 Critical Needs Criterion

Alternative A (the independent application of Critical Needs Criterion #1 (*prevention of predicted land* loss), resulted in a plan combination that excluded diversions in the Breton Sound Basin, but was inclusive of all other potential near-term features and opportunities. As such, Alternative A was grouped into the numerous alternative plans that sought to meet multiple Critical Needs Criteria.

Alternative B (the independent application of Critical Needs Criterion #2 (*sustainability through restored deltaic function*), also produced broad inclusion of potential features and opportunities, but uniformly excluded all barrier shoreline and marsh creation through dredged material use features. Alternative B also excluded any near-term opportunities in the Chenier Plain. However, this alternative was appreciably different from the other 15 alternatives, and was carried forward for further evaluation.

Alternative D (the independent application of Critical Needs Criterion #3 (*sustainability through restoration of geomorphic structure*), produced a combination of features and opportunities focused on barrier shoreline restoration and direct land building focused on maintaining a protective structure. However, this alternative was appreciably different from the other 15 alternatives, and was carried forward for further evaluation.

Alternative H (the independent application of Critical Needs Criterion #4 (*protection of vital socioeconomic resources*), resulted in a diverse combination of features and opportunities that excluded restoration features and opportunities that did not directly benefit infrastructure or property. However, inclusion of Critical Needs Criterion #4 with any other criteria also provided a minor supplemental effect to most other possible alternative combinations. The absence of Critical Needs Criterion #4, in combination with any other criteria, results in only 2 to 3 feature or opportunity exclusions in any of those plans. In addition, Critical Needs Criterion #4, while defining a critical outcome of coastal restoration, could be more appropriately viewed as a synergistic factor in comparison to the critical needs for direct physical restoration of the landscape. As a result, it was determined that the independent application of criterion #4 did not produce a viable alternative plan. Therefore, Alternative H was not considered as a viable alternative plan.

2.6.2 Alternative Plans Designed to Meet Multiple Critical Needs Criteria

Alternative plans seeking to meet multiple Critical Needs Criteria, particularly those that included Critical Needs Criterion #2, quickly reached full inclusion of all or nearly all the potential restoration features and opportunities. Three of the Alternative Plans (Alternatives E, J, and M), while intending to focus on meeting different Critical Needs Criteria, were comprised of almost the same restoration features and opportunities (+/- 4 features/opportunities). Likewise, eight of the Alternative Plans (Alternatives C, F, G, I, K, L, N, and O) had the exact same make-up i.e., they included all potential restoration features and opportunities. These 11 alternative plans were therefore grouped because, due to their similarity, they did not provide a true alternative choice (they were not appreciably different). For the purpose of continued alternative plan evaluation, these 11 alternatives, and Alternative A described previously, were grouped and represented by Alternative Plan N because its inclusion of all potential restoration features and opportunities was an outcome of its design to meet all four Critical Needs Criteria.

2.6.3 Comparison of Alternative Plans

Summarizing the analysis results detailed above, three appreciably different alternatives (Alternative Plans B, D, and N) arose. A comparison of the restoration features and construction costs estimates for these three alternative plans is provided in **table 2-13**.

Table 2-13. Comparison of Alternative Plan Feature Combinations and Construction Costs.

Potential Near-term Features	Alternative Near-term Plans		
	B	D	N
Mississippi River Gulf Outlet Environmental Environmental Restoration Features		$80,000,000	$80,000,000
Maurepas Swamp Reintroductions --			
Small Diversion at Convent / Blind River	$28,564,000		$28,564,000
Small Diversion at Hope Canal	$33,029,000		$33,029,000
Amite River Diversion (spoil bank gapping)	$2,855,000		$2,855,000
Barataria Basin Barrier Shoreline Restoration -- Caminada Headland, Shell Island		$181,000,000	$181,000,000
Small Bayou Lafourche Reintroduction	$90,000,000		$90,000,000
Medium Diversion with Dedicated Dredging at Myrtle Grove	$146,700,000		$146,700,000
Calcasieu Ship Channel Beneficial Use of Dredged Material		$100,000,000	$100,000,000
Modifcation of Caernarvon Diversion for Marsh Creation	$1,800,000		$1,800,000
Modifcation Davis Pond Diversion for Marsh Creation	$1,800,000		$1,800,000
Terrebonne Marsh Restoration Opportunities --			
Optimize Flows & Atchafalaya River Influence in Penchant Baisn	$9,720,000		$9,720,000
Multi-purpose Operation of the Houma Navigation Canal (HNC) Lock	$0		$0
Convey Atchafalaya River Water to Northern Terrebonne Marshes	$132,200,000		$132,200,000
Terrebonne barrier shoreline restoration -- Isle Derniere, E. Timbalier		$84,850,000	$84,850,000
Maintain Land Bridge between Caillou Lake and Gulf of Mexico.		$41,000,000	$41,000,000
Medium Freshwater Diversion at White's Ditch	$35,200,000		$35,200,000
Stabilize Gulf Shoreline at Point Au Fer Island		$32,000,000	$32,000,000
Lac des Allemands area Reintroductions --			
Small Diversion at Lac des Allemands	$17,330,000		$17,330,000
Small Diversion at Donaldsonville	$16,670,000		$16,670,000
Small Diversion at Pikes Peak	$12,940,000		$12,940,000
Small Diversion at Edgard	$13,100,000		$13,100,000
Total Near-term Plan Construction Cost	**$541,908,000**	**$518,850,000**	**$1,060,758,000**

Alternative Plan B focused on restoration of deltaic processes (Critical Needs Criterion #2), and included 15 restoration near-term features and opportunities, all with combinations of river diversion features (**figure 2-12**). Alternative Plan B exhibits some shortcomings because it does not address critical geomorphic structures. Alternative Plan D focused on restoration of geomorphic structure (Critical Needs Criterion #3), and included 11 restoration features and opportunities including shoreline protection, barrier island restoration, and marsh creation (**figure 2-13**). Alternative Plan D exhibits some shortcomings because it does not address the river reintroductions. The body of knowledge concerning application of coastal restoration strategies in Louisiana suggests that while Alternative Plans B and D would have appreciable environmental benefits, they each exhibit some weaknesses in addressing the complete range of study planning objectives and Critical Needs Criteria.

Conversely, Alternative Plan N encompasses all four Critical Needs Criteria and exhibits potential for long-term sustainability because it contains the geomorphic structures, which serve to protect and buffer the diversion feature influence areas from erosive coastal wave action and storm surge. Additionally, the river diversion features contained in Alternative Plan N are more sustainable than other types of restoration features because they receive continuous sediment and nutrient nourishment from the river. **Figure 2-14** provides a graphical representation of this discussion.

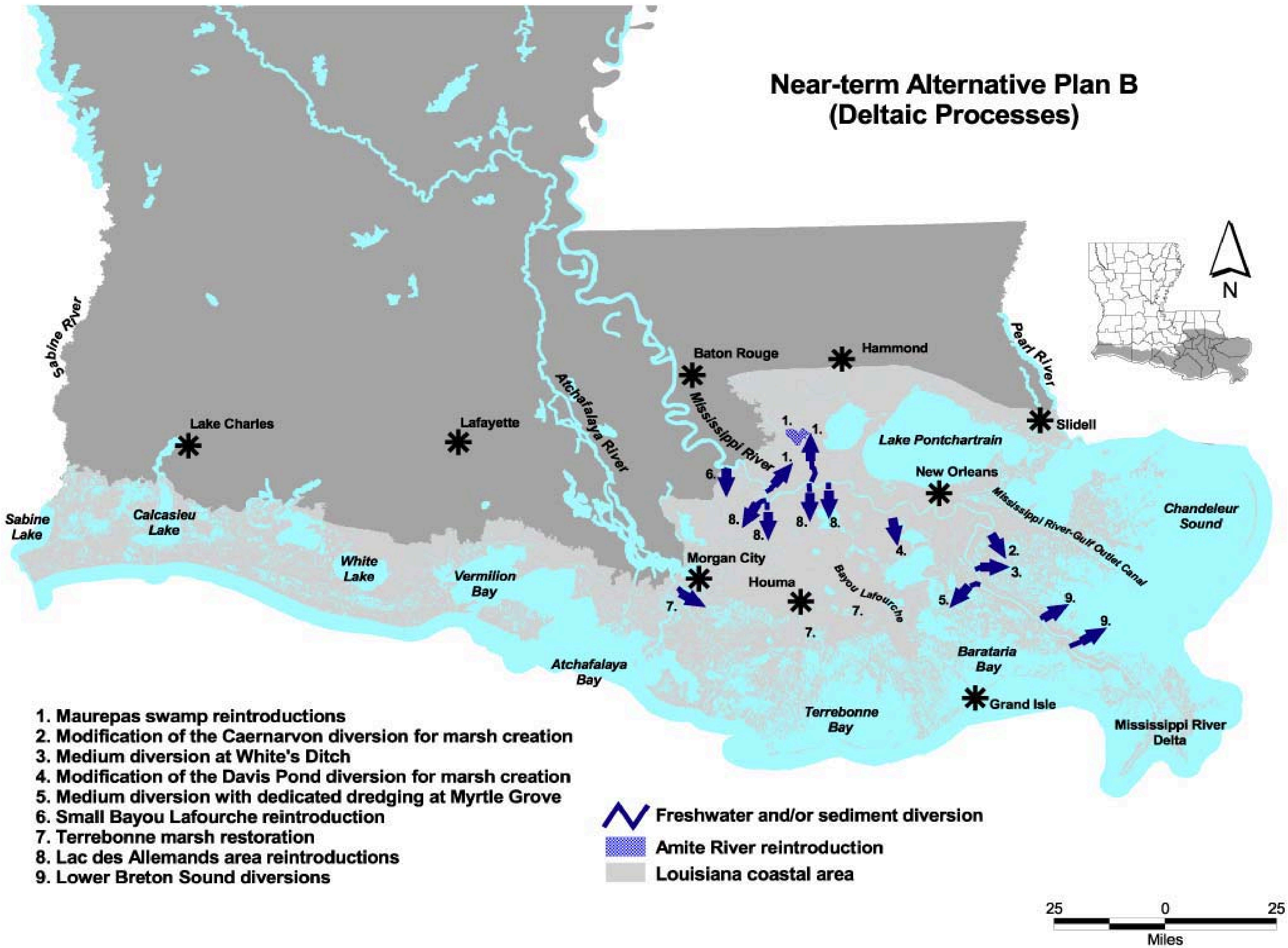


Figure 2-12. Near-Term Alternative Plan B (Deltaic Processes).

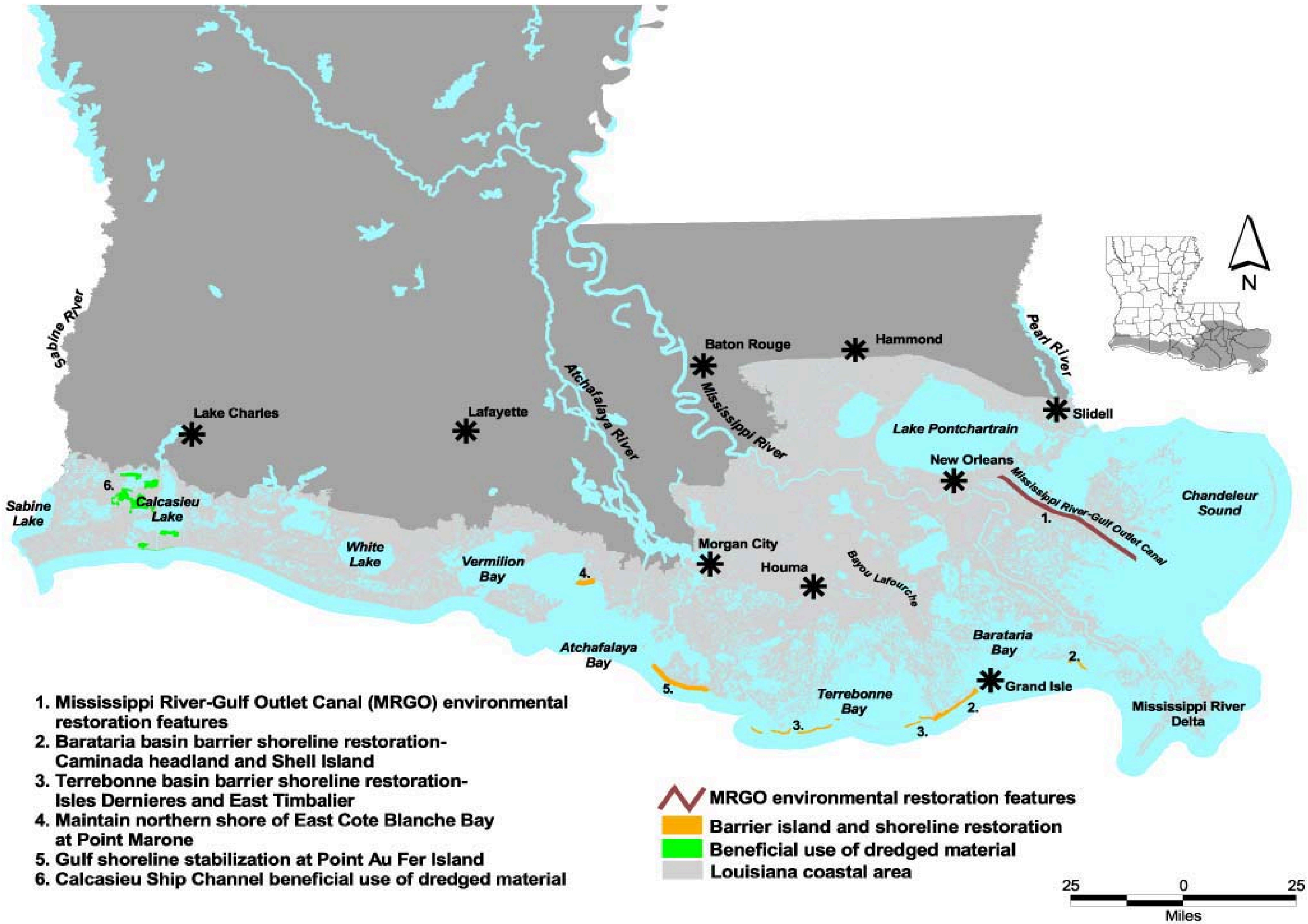


Figure 2-13. Near-Term Alternative Plan D (Geomorphic Structure).

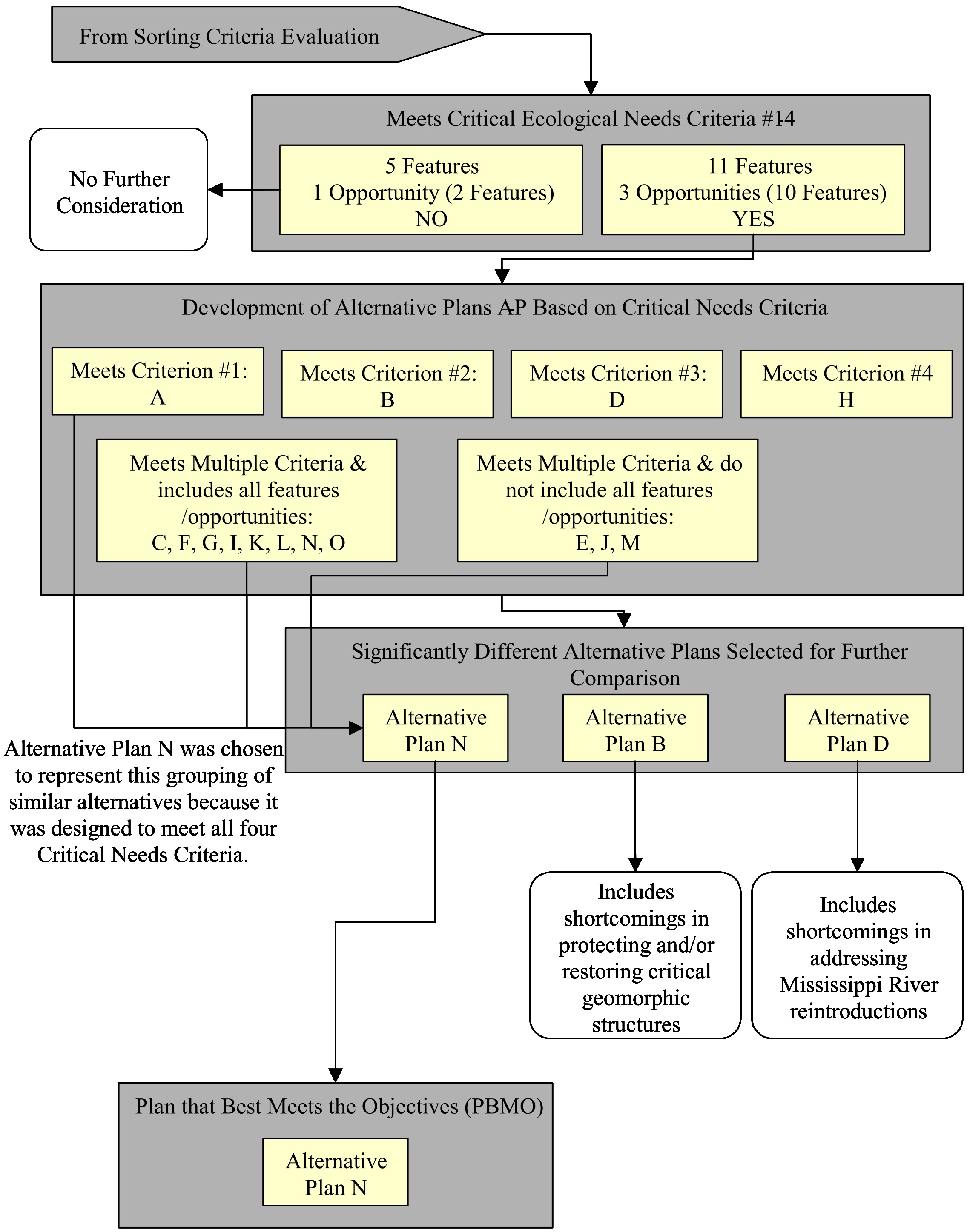


Figure 2-14: Alternative Plan Development and Selection Based on Critical Needs

2.7 PLAN FORMULATION RESULTS

As discussed in section 3.2 PLAN FORMULATION RATIONALE and section 3.3 PLAN FORMULATION, the purpose of the LCA Study was to meet study objectives and thus identify a plan that is effective in addressing the most critical needs within the Louisiana coastal area. The most critical needs are located in those areas of the coast that, without attention, would experience a permanent or severely impaired loss of system stability and function. As such, the development and evaluation of alternative plans focused on identifying combinations of restoration features that best addressed these critical need areas.

The alternative plan that best meets the planning objectives (PBMO) is Alternative Plan N. Of the three alternative plans selected for further comparison, Alternative Plan N best meets the planning objectives and the Critical Needs Criteria.

In addressing the most critical ecologic needs of the Louisiana coast, this plan is also effective in meeting the defined study objectives. As presented previously in this report, the study objectives are as follows:

Hydrogeomorphic Objectives

1. Establish dynamic salinity gradients that reflect natural cycles of freshwater availability and marine forcing (tidal action or exchange).
2. Increase sediment input from sources outside estuarine basins, and manage existing sediment resources within estuarine basins, to sustain and rejuvenate existing wetlands and rebuild marsh substrate.
3. Maintain or establish natural landscape features and hydrologic processes that are critical to sustainable ecosystem structure and function.

Ecosystem Objectives

1. Sustain productive and diverse fish and wildlife habitats.
2. Reduce nutrient delivery to the Continental shelf by routing Mississippi River waters through estuarine basins while minimizing potential adverse effects.

2.7.2 Effectiveness of the Plan in Meeting the Study Objectives

The PBMO addresses the most immediate and critical needs of the ecosystem in attaining the study objectives. The rehabilitation of the coastal ecosystem by promoting the distribution of riverine freshwater, nutrients, and sediment using natural processes and ensuring the structural integrity of the estuarine basins is key to this sustainable solution. A sustainable ecosystem would support Nationally important living resources, provide a sustainable and diverse array of fish and wildlife habitats, reduce nitrogen delivery to offshore gulf waters, and provide infrastructure protection and a sustainable resource base necessary to support NER goals.

The PBMO accomplishes the stated Hydrogeomorphic Objective 1. In the Deltaic Plain, the PBMO identifies reintroductions of freshwater from the Mississippi River in multiple locations from small to moderate scales.

The PBMO also addresses Hydrogeomorphic Objective 2 as the recommended actions for the Deltaic Plain are founded primarily on the introduction of Mississippi River water, nutrients, and suspended sediment. The PBMO identifies one restoration feature and three restoration opportunities (composed of seven features) for the introduction of Mississippi River water and recommendations for the investigation of rehabilitation or modification of two existing diversion structures in the Deltaic Plain. In addition, the PBMO identifies two restoration features capitalizing on the direct introduction of Mississippi River sediment. The PBMO directs attention to many areas where the prevention of wetland loss is critical to maintaining the ability to provide sustainable coastal restoration in the future. In the Chenier Plain, the PBMO focuses on providing continued stability to preserve the viability of future restoration actions.

Major components of the PBMO in the Deltaic Plain are directed at meeting Hydrogeomorphic Objective 3. The conservation and restoration of barrier islands and shorelines are large components of protecting the coastline from storm damage. Restoration features of the PBMO include a critical headland area and a critical land bridge in the deltaic plain. Proposed features and opportunities, located across the entire coast, assure that landscape features are restored and maintained to provide additional potential protection from storm damage.

Ecosystem Objective 1 is addressed by the PBMO, which contributes to the increased introduction of Mississippi River water, nutrients, and suspended sediment, the improved management of Atchafalaya River water, nutrients, and suspended sediment in the Deltaic Plain, and the expansion of beneficial use of dredged material in the Chenier Plain. The features recommended in the Deltaic Plain provide major improvements in connectivity and material exchange.

While the overall quantity of wetland area is projected to increase with the execution of the proposed restoration effort, the cumulative quantities of suitable habitat are projected to decline for some species in localized areas of the coast. However, it was estimated that the overall useable amounts of the various habitat types would remain relatively plentiful throughout the 50-year period analyzed. Based on earlier ecological model analysis, certain saline species are anticipated to experience the most notable change in habitat levels. For most species across the coast, suitable habitat levels are expected to remain at or slightly below current levels. It is expected that many freshwater-associated species should see increases in levels of suitable habitat. These trade-offs are consistent with the reintroduction of deltaic land building processes. Even with the anticipated changes in cumulative habitat suitability, overall diversity is expected to remain relatively high and close to current conditions in keeping with the ecosystem objective.

The effectiveness of the PBMO in achieving Ecosystem Objective 2 has also been taken into account. The Action Plan for Reducing, Mitigating and Controlling Hypoxia in the Northern Gulf of Mexico states that the best current science indicates that efforts to reduce nutrient loadings in the Mississippi River Basin should be aimed at achieving a 30 percent reduction (from the average discharge in the 1980-1996 time frame) in nitrogen discharges to the Gulf (on a 5-year running average) to be consistent with the coastal goal for reducing the aerial extent of hypoxia in the Gulf. Based on an average annual loading of 1.6 million metric tons, a 30 percent reduction would be 480,000 tons annually (CENR 2000). The PBMO would make a small contribution towards meeting this goal. However, the knowledge gained from implementation of the projects in the PBMO and from the large-scale studies could greatly facilitate the implementation of larger reintroduction projects, which could provide greater benefits in terms of reducing Gulf hypoxia.

2.7.2.1 Environmental operating principles/achieving sustainability

Striving to achieve environmental sustainability is a core objective both for the development and for the implementation of an NER plan. Although the result of the LCA Study effort does not identify the final NER plan, the PBMO is focused on producing economic and environmental outcomes that will support and reinforce one another over both the near and long-term. The recognition of the interdependence of biological resources and the physical and human environment has driven the development of many of the guiding principals and tools applied in this study. As a result, the restoration features and opportunities that make up the PBMO produce balance and synergy between human development activities and natural systems.

The restoration features and opportunities in the PBMO that point toward additional investigations are intended to continue to shape activities and decisions currently under the authority of the USACE in order to increase the continued viability of the natural systems within which they occur. The PBMO is also intended to provide a mechanism to continue to assess and address cumulative impacts to the environment, and to achieve consistency by applying a systems approach to the full life cycle of all related water resources activities in the Louisiana coastal area.

2.7.2.2 Components of the Plan that Best Meets the Objectives (PBMO)

The PBMO consists of the components addressed below. These combined components represent the best near-term approach for addressing coastal wetlands loss in Louisiana. The features and opportunities addressed below are viewed as representative of the most likely anticipated action and provide an optimal starting points for the detailed investigations that will lead to project justification and implementation. The projects that are ultimately authorized for construction would be optimized for location, scale, and beneficial output to be documented in a decision document supporting final NEPA compliance prior to implementation.

2.7.2.2.1 *Near-term critical restoration features and opportunities*

The first principal component of the PBMO is the group of features and opportunities identified to meet the critical near-term ecosystem needs of the Louisiana coastal wetlands. The restoration features and opportunities representing solutions to the Critical Needs included in the PBMO are:

- MRGO environmental restoration features
- Maurepas Swamp Reintroductions:

  - Small diversion at Hope Canal
  - Small diversion at Convent/Blind River
  - Increase Amite River Diversion Canal influence by gapping banks
- Barataria Basin barrier shoreline restoration
- Small Bayou Lafourche reintroduction
- Medium diversion with dedicated dredging at Myrtle Grove
- Calcasieu Ship Channel Beneficial Use
- Modification of Caernarvon diversion
- Modification of Davis Pond diversion
- Terrebonne marsh restoration opportunities:
  - Optimize flows and Atchafalaya River influence in Penchant Basin
  - Multi-purpose operation of Houma Navigation Canal (HNC) Lock
  - Convey Atchafalaya River water to Northern Terrebonne marshes via a small diversion in the Avoca Island levee, repairing eroding banks of the GIWW, enlarging constrictions in the GIWW below Gibson and in Houma and Grand Bayou conveyance channel construction/enlargement
- Terrebonne Basin barrier shoreline restoration
- Maintain land bridge between Caillou Lake and Gulf of Mexico
- Medium diversion at White's Ditch
- Gulf shoreline stabilization at Point Au Fer Island
- Lac des Allemands area reintroductions:
  - Small diversion at Lac des Allemands
  - Small diversion at Donaldsonville
  - Small diversion at Pikes Peak
  - Small diversion at Edgard

2.7.2.2.2 **Large-scale and long-term concepts requiring detailed study**

The second principal component of the PBMO is the identification of large-scale, long-range studies of long-term restoration concepts. These long-range initiatives typically define fundamental changes to the hydrogeomorphic or ecologic structure, function, or management of the Louisiana coast. These concepts, which represent major opportunities for coastal restoration, require detailed study and development to determine the probable impacts (beneficial and adverse) of such features in order to determine if these projects are desirable and can be integrated into the plan for coastal restoration. These concepts also include some levels of uncertainty, which are typically so extensive in scale that resolution through a demonstration project is impractical. As a general rule, large-scale diversions (flow greater than 15,001 cfs [54 cms]) were deemed impractical in the near-term because of their being mutually exclusive with important concepts such as Third Delta. River resource hydrodynamic studies would necessarily evaluate these larger scale diversions in concert. The large-scale and long-term concepts identified in the PBMO include:

- Mississippi River Hydrodynamic Study
- Mississippi River Delta Management Study
- Third Delta Study

- Chenier Plain Freshwater and Sediment Management and Allocation Reassessment Study
- Acadiana Bays Estuarine Restoration Feasibility Study
- Upper Atchafalaya Basin Study (This study would include evaluation of alternative operational schemes of Old River Control Structure and will be funded under MR&T)

2.7.2.2.3 ***Science and Technology (S&T) Program and potential demonstration projects***

The third principal component of the PBMO is the establishment of a S&T Program to address both near and long-term uncertainties in the implementation and execution of the plan. A portion of this component would include the execution of focused demonstration projects to resolve specific uncertainties and provide insight to the programmatic short and long-range implementation of the PBMO. **Figure 2-15** illustrates the PBMO.

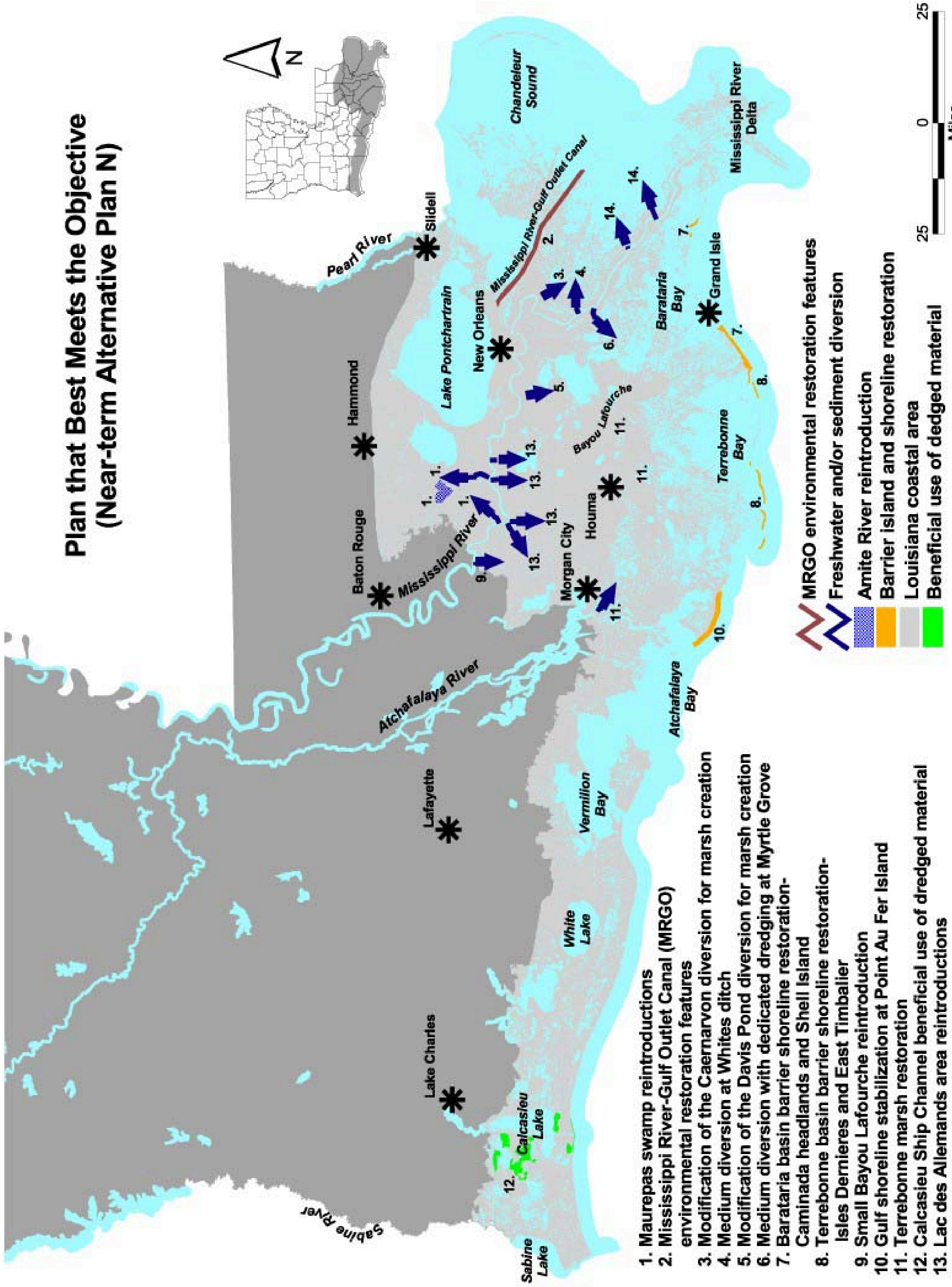


Figure 2-15. Plan That Best Meets the Objectives (PBMO).

2.8 PLAN IMPLEMENTATION

Within plan implementation, there are several key individuals and organizations that are introduced and discussed in detail. For clarity, the following abbreviated terms apply:

- Assistant Secretary of the Army for Civil Works: the Assistant Secretary
- U.S. Army Corps of Engineers, Headquarters: Headquarters
- U.S. Army Corps of Engineers, Mississippi Valley Division: the Division
- U.S. Army Corps of Engineers-Mississippi Valley Division, New Orleans District: the District
- Coastal Louisiana Ecosystem Protection and Restoration Task Force: the Task Force
- State of Louisiana: the state

The State of Louisiana, acting through the LDNR, is the non-Federal cost share sponsor.

2.8.1 Evaluation of PBMO Implementation

Sequencing and scheduling of the alternative plan that bests meets objectives (PBMO) was required to determine an implementation plan. This implementation plan evaluation is based on the ability to meet the near-term (5 to 10 years) and critical needs. While these criteria identified the features that would comprise the most appropriate near-term restoration effort, the sequencing of the PBMO features needed to consider implementation parameters and constraints and identify the most effective means of executing the plan. The features of the PBMO were sequenced based on the highest capability for achieving construction approval first and then scheduled according to resource requirements and capabilities. Representatives of the cost share partners from the District and the LDNR, representing the state, established a set of assumptions and rules to sequence and schedule implementation of all components of the plan. The results of this evaluation are discussed in greater detail in a later part of this section.

2.8.1.2 Assumptions and Rules

There were five major assumptions made in the preparation of the implementation schedule prepared for this report. They are related to project authorizations, large-scale and long-term studies, demonstration projects, and funding and manpower resources. These are described in the following bullets. A set of sequencing rules was also developed to guide development of the implementation schedule. These rules are also described in more detail in the following bullets.

Assumptions

- Near-term critical restoration feature feasibility-level decision documents and feasibility studies could begin in October 2004 based upon existing authority;
- Large-scale and long-term studies could begin in October 2004 based upon existing authority;
- Feasibility-level decision document preparation for demonstration projects could begin in January 2005 based upon successful completion of the Chief's Report in December 2004 and future WRDA authorization;

- The annual cost shared execution capability of the District and non-Federal sponsor would be approximately $200 million per year on average; and
- All components should have construction initiated within the next 10 years.

Sequencing Rules

- Near-term critical restoration features that exhibit high degree of design development and have initiated NEPA compliance documentation (EIS)
- Near-term critical restoration features that if delayed, could result in "Loss of Opportunity" to restore a critical needs area;
- Modifications to existing structures already identified as major opportunities for contribution to LCA objectives; and
- Qualitative valuations that resulted in determining the features resident in the PBMO also allow for a prioritized ordering of the remaining features.

2.8.1.3 Implementation Scheduling Evaluation

Once the implementation sequence for the PBMO components had been determined, the Federal and State cost share partners began development of the 10-year implementation schedule. Based on the assumptions and rules for scheduling of plan components, all PBMO projects could not be implemented simultaneously. In addition, discussions with the non-Federal sponsor led to the conclusion that the total annual project expenditures would be limited to approximately $200 million per year on average (attachment 3 NON-FEDERAL SPONSOR FINANCIAL CAPABILITY). The inclusion of all plan components would force the implementation schedule to either exceed the average available funding limitation, or would result in initial construction of some features in the PBMO being delayed beyond the 10-year planning period.

To facilitate the initial efforts in sequencing the near-term critical features, a number of those features that had been grouped were considered separately to identify if they met the specific sequencing rules. The intent of grouping features was to indicate that those features required common consideration and analysis during the decision document phase. The assumption in considering implementation of grouped features separately is that the initial feature sequenced in any group would need to consider and reconcile the combined effects of the specific group. The ultimate implementation sequence of grouped features is not a dependent function if they have been properly assessed and scaled from the outset.

The critical near-term features of the PBMO were also reviewed in consideration of the 10-year timeframe to identify any additional conflicts or efficiencies in implementing the PBMO not captured by the established assumptions and sequencing rules. This review revealed that the Penchant Basin Restoration feature could be implemented more effectively by allowing the feature to proceed to approval under the CWPPRA program. The sequencing for this feature was identified as being beyond year 5 in the near-term plan. Construction approval and funding through the CWPPRA program could potentially be achieved for this feature in 2 to 3 years. As noted above, it is assumed that consideration of this feature, in conjunction with other hydrologic modification features with which it was grouped, would be performed prior to the implementation of the any of these features.

The review also revealed a consistent potential near-term conflict between the Lac Des Allemands Reintroduction features and the large-scale, long-range Third Delta study. The potential for hydrologic conflicts, or possibly more effective means of achieving the benefits through the larger feature, indicated that these near-term features should not be initiated until after completion of the large-scale study.

Considering this information, it was deemed reasonable to consider these features last in the sequencing. As a result, the Penchant Basin Restoration, and Lac Des Allemands were placed last in the sequencing and resulted in the inability to execute these features within the 10-year near-term timeframe.

Because beneficial use has been added as a program-wide component for this restoration technique, the beneficial use of dredged material from the Calcasieu Ship Channel would be evaluated for implementation as part of the larger beneficial use program. Evaluation of the Calcasieu River project, as part of the overall beneficial use program, would ensure that the most effective and feasible projects would be implemented more quickly.

Utilizing the sequencing rules, and the considerations discussed above the elements of the PBMO were sequenced as shown in **table 2-14**

Table 2-14. Sequenced PBMO Components.

Near-term Critical Restoration Features

- MRGO Environmental Restoration features
- Small Diversion at Hope Canal
- Barataria Basin Barrier Shoreline Restoration
- Small Bayou Lafourche Reintroduction
- Medium Diversion with dedicated dredging at Myrtle Grove
- Multi-purpose operation of Houma Navigation Canal Lock
- Terrebonne Basin Barrier Shoreline Restoration
- Maintain Land Bridge between Caillou Lake and Gulf of Mexico
- Small Diversion at Convent / Blind River
- Increase Amite River Diversion Canal Influence by gapping banks
- Medium Diversion at White's Ditch
- Stabilize Gulf Shoreline at Point Au Fer Island
- Convey Atchafalaya River water to Northern Terrebonne Marshes
- Modification of Caernarvon Diversion
- Modification of Davis Pond Diversion
- Penchant Basin Restoration
- Lac Des Allemands Reintroductions
- Calcasieu River Beneficial Use

The result of the scheduling evaluation effort was the identification of the set of near-term critical features that met sorting and critical need criteria, and could be implemented within the time and funding parameters identified for the near-term effort. This subset of the PBMO, along with other long-term and programmatic elements, was designated as the LCA Plan in the draft report prepared for public review and now represents the major features of the near-term critical restoration effort identified in the LCA Plan. A list of the near-term critical features contained in this subset is shown in **table 2-15**, following the discussion of authorization process considerations.

2.8.1.4 Project Authorization Process Analysis

After identifying the subset of near-term critical features to be included in the LCA Plan the Federal and state cost-share partners evaluated alternative implementation scenarios for all the components of the LCA Plan using two different authorization procedures:

(1) Specific Congressional authorization for all critical features with implementation subject to approval of feasibility-level decision documents by the Secretary of the Army (a process hereinafter referred to as "conditional authorization" elsewhere in the report;

(2) Future Congressional construction authorization for all critical features (i.e., the typical WRDA authorization process used for authorization of water resources projects, in which investigations are performed to complete feasibility reports and, upon completion, submitted for construction authorization under future WRDAs).

These two authorization processes have in common the requirement, which applies to all components of the LCA Plan, for completion and approval of detailed decision and NEPA compliance documents prior to the initiation of construction. In the case of the conditional authorization, the necessary Congressional authorization to proceed would be provided conditional to the approval of the required documents by the Secretary of the Army. For future Congressional construction authorization, approval of all required documents by the Secretary of the Army would be completed prior to submission to Congress, which then would provide final approval and authorization for construction at one time.

In this first scheduling iteration, the comparison of the implementation schedule results indicate that the major difference between the authorization scenarios was in the execution capability within the first five years. Both scenarios indicate execution at an annual capability averaging approximately $200 million beyond year 5.

Another iteration was conducted to investigate the effects of conditional authorization for only the five most highly critical features that met the first sequencing rule. Substantial design development and NEPA compliance efforts have been undertaken for these projects. Based on these considerations, the Federal and state cost share partners determined that these features could be ready for construction approval prior to the next opportunity for authorization. This scheduling iteration identified that conditional authorization for only the top five restoration features, with future Congressional construction authorization for the remaining 10 features, provided the same increased execution capability as the conditional authorization for all 15 restoration features. It became apparent that annual funding limitations, as well as the typical process of seeking construction approval under WRDA authorization, limited the plan's execution. The implementation scenario supported by conditional authorization for the top five restoration features is optimal for expediting implementation of features that address the most urgent needs of the coastal area. This scenario would facilitate the most effective and efficient implementation leading to the identification of the LCA plan. Without conditional authority, both the approval to proceed, and ability to budget for implementation, would setback the construction and operation of these critical restoration features.

Table 2-15 shows the LCA Plan near-term critical features recommended for conditional authorization and approval with future Congressional authorization.

Table 2-15. Scheduled LCA Plan Components.

Recommended for Conditional Authorization
Near-term Critical Restoration Features • MRGO Environmental Restoration features • Small Diversion at Hope Canal • Barataria Basin Barrier Shoreline Restoration, Caminada Headland, Shell Island • Small Bayou Lafourche reintroduction • Medium diversion with dedicated dredging at Myrtle Grove
Recommended for Approval With Future Congressional Construction Authorization
Other Near-term Critical Restoration Features • Multi-purpose operation of Houma Navigation Canal Lock • Terrebonne Basin Barrier Shoreline Restoration • Maintain land bridge between Caillou Lake and Gulf of Mexico • Small Diversion at Convent / Blind River • Increase Amite River Diversion Canal Influence by gapping banks • Medium diversion at White's Ditch • Stabilize Gulf Shoreline at Point Au Fer Island • Convey Atchafalaya River water to Northern Terrebonne Marshes • Modification of Caernarvon Diversion • Modification of Davis Pond Diversion

2.8.2 Summary of the LCA Plan Components and Implementation Schedule

2.8.2.1 Description of the LCA Plan

As stated in section 3.1 PLANNING CONSTRAINTS, the resolution of S&T uncertainties requires continued science and technology development supported by demonstration projects. In addition, there is coastwide beneficial use of dredged material, as well as potential modifications of existing water resource projects that may offer the opportunities to advance restoration. To better achieve completeness and effectiveness, the PDT incorporated these two additional plan components for programmatic authorization. This resultant multi-component LCA Plan represents the best near-term approach for addressing ecosystem degradation in Louisiana. The LCA program relies on Congressional approval of the LCA Plan as a framework for conditional and future Congressional construction authorization actions. Components of the LCA Plan are:

- Conditional authorization for implementation of five near-term critical restoration features for which construction can begin within 5 to 10 years, subject to approval of feasibility-level decision documents by the Secretary of the Army;
- Programmatic Authorization of a Science and Technology (S&T) Program;
- Programmatic Authorization of Science and Technology Program Demonstration Projects;
- Programmatic Authorization for the Beneficial Use of Dredged Material;
- Programmatic Authorization for Investigations of Modification of Existing Structures;
- Approval of 10 additional near-term critical restoration features and authorization for investigations to prepare necessary feasibility-level reports to be used to present recommendations for potential future Congressional authorizations (hereinafter referred to as "Congressional authorization"); and
- Approval of investigations for assessing six potentially promising large-scale and long-term restoration concepts.

Figure 2-16 and **tables 2-16a** and **2-16b** list the components of the LCA Plan.

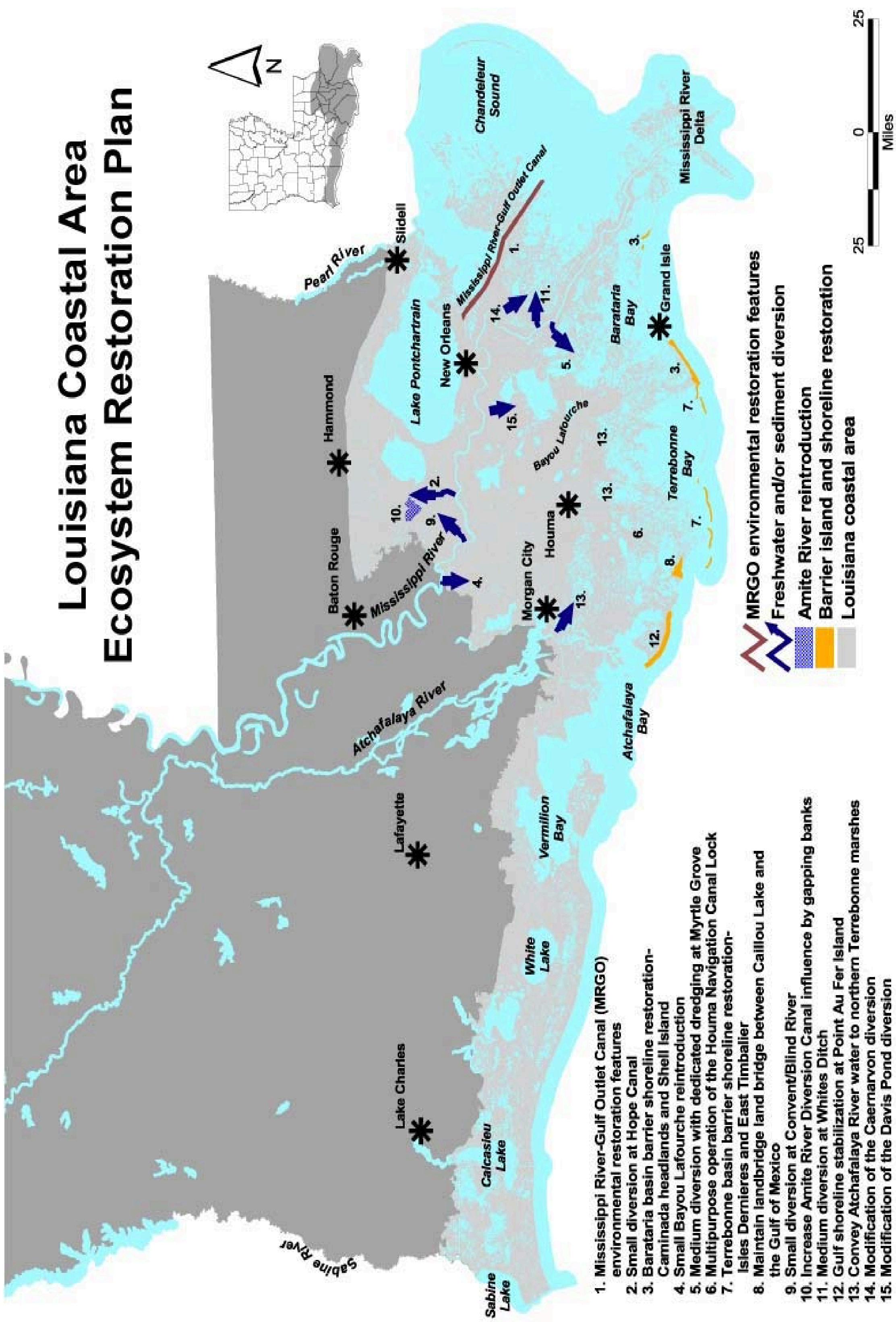


Figure 2-16. Near-Term Critical Restoration Features of the LCA Plan.

Table 2-16a. Components of the LCA Plan.

Recommended for Conditional or Programmatic Authorization
1. <u>Conditional Authorization of Near-term Critical Restoration Features</u> • MRGO Environmental Restoration Features • Small Diversion at Hope Canal • Barataria Basin Barrier Shoreline Restoration • Small Bayou Lafourche Reintroduction • Medium Diversion with Dedicated Dredging at Myrtle Grove 2. <u>Programmatic Authorization of the S&T Program</u> 3. <u>Programmatic Authorization of Demonstration Projects</u> 4. <u>Programmatic Authorization for the Beneficial Use of Dredged Material</u> 5. <u>Programmatic Authorization to Initiate Investigations of Modifications of Existing Water Control Structures</u>

Table 2-16b. Components of the LCA Plan.

Recommended for Approval With Future Congressional Construction Authorization
6. <u>Other Near-term Critical Restoration Features</u> • Multi-purpose operation of Houma Navigation Canal Lock • Terrebonne Basin Barrier Shoreline Restoration • Maintain land bridge between Caillou Lake and Gulf of Mexico • Small Diversion at Convent / Blind River • Increase Amite River Diversion Canal Influence by gapping banks • Medium diversion at White's Ditch • Stabilize Gulf Shoreline at Point Au Fer Island • Convey Atchafalaya River water to Northern Terrebonne Marshes • Modification of Caernarvon Diversion • Modification of Davis Pond Diversion 7. <u>Large-scale and Long-term Concepts Requiring Detailed Study</u> • Mississippi River Hydrodynamic Study • Mississippi River Delta Management Study • Third Delta Study • Chenier Plain Freshwater and Sediment Management and Allocation Reassessment Study • Acadiana Bays Estuarine Restoration Study • Upper Atchafalaya Basin Study

2.8.2.2 Sequencing of the LCA Plan

Tables 2-17a-d show the implementation schedule for the LCA Plan, developed with conditional authorization for five critical features, programmatic authorization features, and future Congressional construction authorization for the other 10 near-term critical features.

Table 2-17a. The LCA Plan Implementation Schedule

Project: 101204
Time Now: 10/01/04
Start: 10/01/04
Finish: 09/29/23
Run: 10/15/04

The LCA Plan Implementation Schedule

1 of 4

Planned
Critical
Milestone
Progress

ID	Activity Desc.	Duration	Early Start	Early Finish
A01A	MRGO Environmental Restoration Features (SP1) DD	390d	01/10/05	07/07/06
A01B	MRGO Environmental Restoration Features (SP1) PED	520d	07/10/06	07/04/08
A01C	MRGO Enviro. Rest. Construction	1430d	07/07/08	12/27/13
A01C2	MRGO Enviro. Rest. E&D, S&A	1430d	07/07/08	12/27/13
A01C3	MRGO Enviro. Rest. RE	1430d	07/09/07	12/28/12
A01C4	MRGO Enviro. Rest. Monitoring	1300d	12/30/13	12/21/18
B02A	Small Diversion at Hope Canal (SP1) DD	650d	04/04/05	09/28/07
B02B	Small Diversion at Hope Canal -PED	520d	10/01/07	09/25/09
B02C	Div. at Hope Canal Construction	1300d	09/28/09	09/19/14
B02C2	Div. at Hope Canal E&D, S&A	1300d	09/28/09	09/19/14
B02C3	Div. at Hope Canal RE	1300d	09/29/08	09/20/13
B02C4	Div. at Hope Canal Monitoring	1300d	09/22/14	09/13/19
C03A	Barataria Basin Barrier Shore Rest. -Caminada ,Shell Is. SP2	1415d	05/01/00	09/30/05
C03B	Barat Basin Barrier Shore Rest. Cam., Shell-DD	390d	04/04/05	09/29/06
C03BA	Barat. Basin Barrier Shore Rest. Cam., Shell-PED	520d	10/02/06	09/26/08
C03C	Barat Basin Barrier Shore. Rest. Cam, Shell Is Const	1040d	09/29/08	09/21/12
C03C2	Barat Basin Barrier Shore. Rest. Cam, Shell Is E&D, S&A	1040d	09/29/08	09/21/12
C03C3	Barat Basin Barrier Shore. Rest. Cam, Shell Is RE	1040d	10/01/07	09/23/11
C03C4	Barat Basin Barrier Shore. Rest.Cam,Shell Monitoring	1300d	09/24/12	09/15/17
D06A	Small Bayou LaFourche Reintroduction (SP3)-DD	780d	01/10/05	01/04/08
D06B	Small Bayou LaFouche Reintroduction (SP3)-PED	520d	01/07/08	01/01/10
D06C	Small Bayou La Fourche Reintro Construction	1820d	01/04/10	12/23/16
D06C2	Small Bayou La Fourche Reintro E&D, S&A	1820d	01/04/10	12/23/16
D06C3	Small Bayou La Fourche Reintro RE	1820d	01/05/09	12/25/15
D06C4	Small Bayou LaFouche Reintro Monitoring	1300d	12/26/16	12/17/21
E07A	Medium Diversion w/ Dedicated Dredging at Myrtle Grove- DD	780d	04/04/05	03/28/08
E07B	Medium Diversion W/ Dedicated Dredging at Myrtle Grove-PED	520d	03/31/08	03/26/10
E07C	Medium Diversion at Myrtle Grove Construction	1560d	03/29/10	03/18/16
E07C2	Medium Diversion at Myrtle Grove E&D, S&A	1560d	03/29/10	03/18/16
E07C3	Medium Diversion at Myrtle Grove RE	1560d	03/30/09	03/20/15
E07C4	Medium Diversion at Myrtle Grove Monitoring	1300d	03/21/16	03/12/21
FST01	Science & Tech Program FY05-FY15	2537d	01/10/05	09/30/14

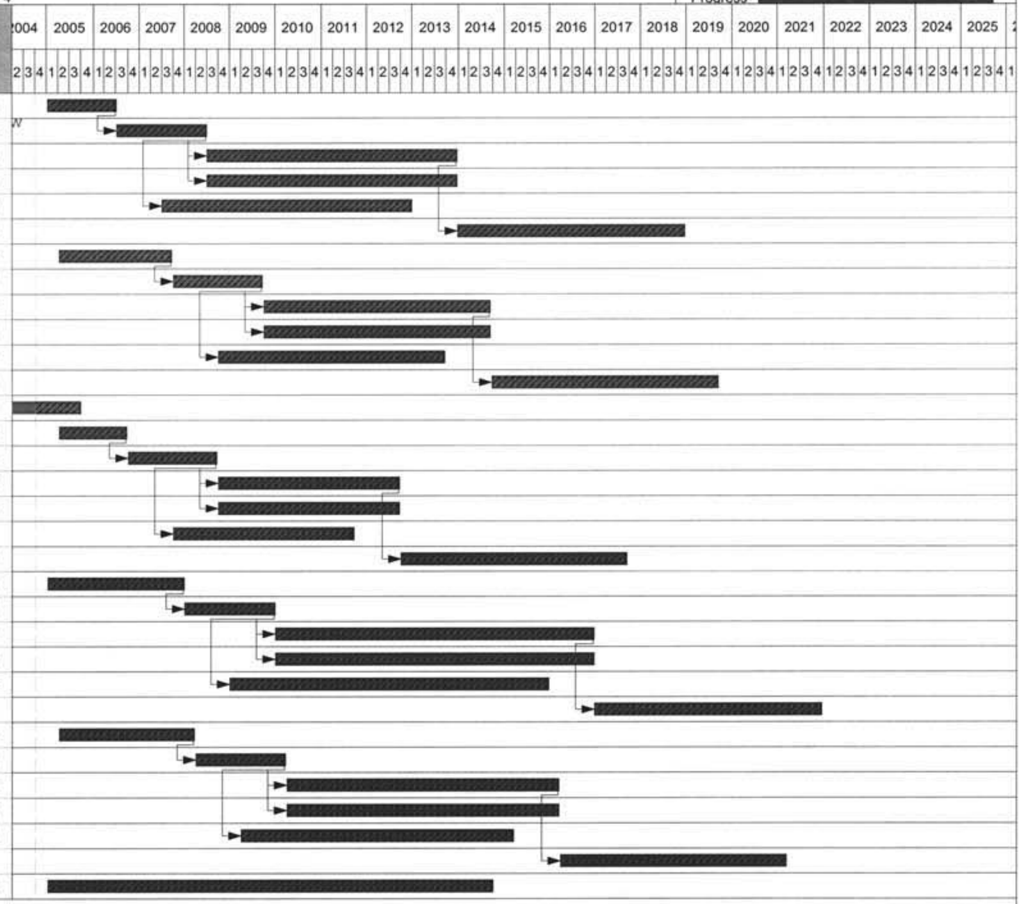


Table 2-17b. The LCA Plan Implementation Schedule

Project: 101204
Time Now: 10/01/04
Start: 10/01/04
Finish: 09/29/23
Run: 10/15/04

The LCA Plan Implementation Schedule

2 of 4

ID	Activity Desc.	Duration	Early Start	Early Finish
GDEMO5C	Demo Projects-DD	1695d	04/04/05	09/30/11
GDEMO5D	Demo Projects-PED	1565d	10/02/06	09/28/12
GDEMO5E	Demo Projects-RE	1827d	10/01/07	09/30/14
GDEMO5F	Demo Projects-CONSTRUCTION	2350d	09/29/08	09/29/17
GDEMO5G	Demo Projects-MONITORING	3135d	09/27/10	09/30/22
GDEMO5H	Demo Projects-E&D	2350d	09/29/08	09/29/17
GDEMO5I	Demo Projects-S&A	2350d	09/29/08	09/29/17
GDEMO5J	Demo Projects-MONITORING RPT	3138d	09/21/11	09/29/23
HPGMA	Prog. Auth. for Beneficial Use of Dredged Mtrl.-DD	2738d	04/04/05	09/30/15
HPGMB	Prog. Auth. for Beneficial Use Construction	2340d	04/03/07	03/21/16
HPGMB2	Prog. Auth. for Beneficial Use RE	2340d	04/03/06	03/20/15
IMODA	Investigation of Mod to Existing Structures-Other Opportun.	2410d	07/05/05	09/29/14
J08A	Multi-Purpose Ops of Houma Nav. Canal (HNC) Lock-DD	390d	07/06/11	01/01/13
J08B	Multi-Purpose Ops of Houma Nav. Canal (HNC) Lock PED	260d	01/02/13	12/31/13
J08B2	Multi-Purpose Ops of Houma Nav. Canal (HNC) Lock RE	520d	01/02/13	12/30/14
J08B3	Multi-Purpose Ops of Houma Nav Canal Lock E&D S&A	520d	01/01/14	12/29/15
J08B4	Multi-Purpose Ops of Houma Nav. Canal Lock-Monitoring	1300d	12/30/15	12/22/20
K09A	Terr. Basin Barrier Shore. Restoration -DD	520d	10/01/10	09/27/12
K09B	Terr. Basin Barrier Shore. Restoration PED	520d	09/28/12	09/25/14
K09C	Terr. Basin Barrier Shore. Restoration Construction	726d	09/26/14	07/07/17
K09C2	Terr. Basin Barrier Shore. Restoration E&D, S&A	726d	09/26/14	07/07/17
K09C3	Terr. Basin Barrier Shore. Restoration RE	726d	09/27/13	07/08/16
K09C4	Terr. Basin Barrier Shore. Rest. Monitoring	1300d	07/10/17	07/01/22
L10A	Maintain Land Bridge b/t Caillou Lk. and Gulf of Mexico-DD	520d	10/01/09	09/28/11
L10B	Maintain Land Bridge b/t Caillou Lake and Gulf of Mexico-PED	520d	09/29/11	09/25/13
L10C	Maintain Land Bridge b/t Caillou Lake & Gulf Construction	520d	09/26/13	09/23/15
L10C2	Maintain Land Bridge b/t Caillou Lake & Gulf E&D, S&A	520d	09/26/13	09/23/15
L10C3	Maintain Land Bridge b/t Caillou Lake & Gulf RE	520d	09/27/12	09/24/14
L10C4	Maintain Land Bridge b/t Caillou Lk & Gulf Monitoring	1300d	09/24/15	09/16/20
M11A	Small Diversion at Convent / Blind River DD	780d	10/01/07	09/24/10
M11B	Small Diversion at Convent/Blind River PED	520d	09/27/10	09/21/12
M11C	Small Diversion at Convent/Blind River Construction	1300d	09/24/12	09/15/17

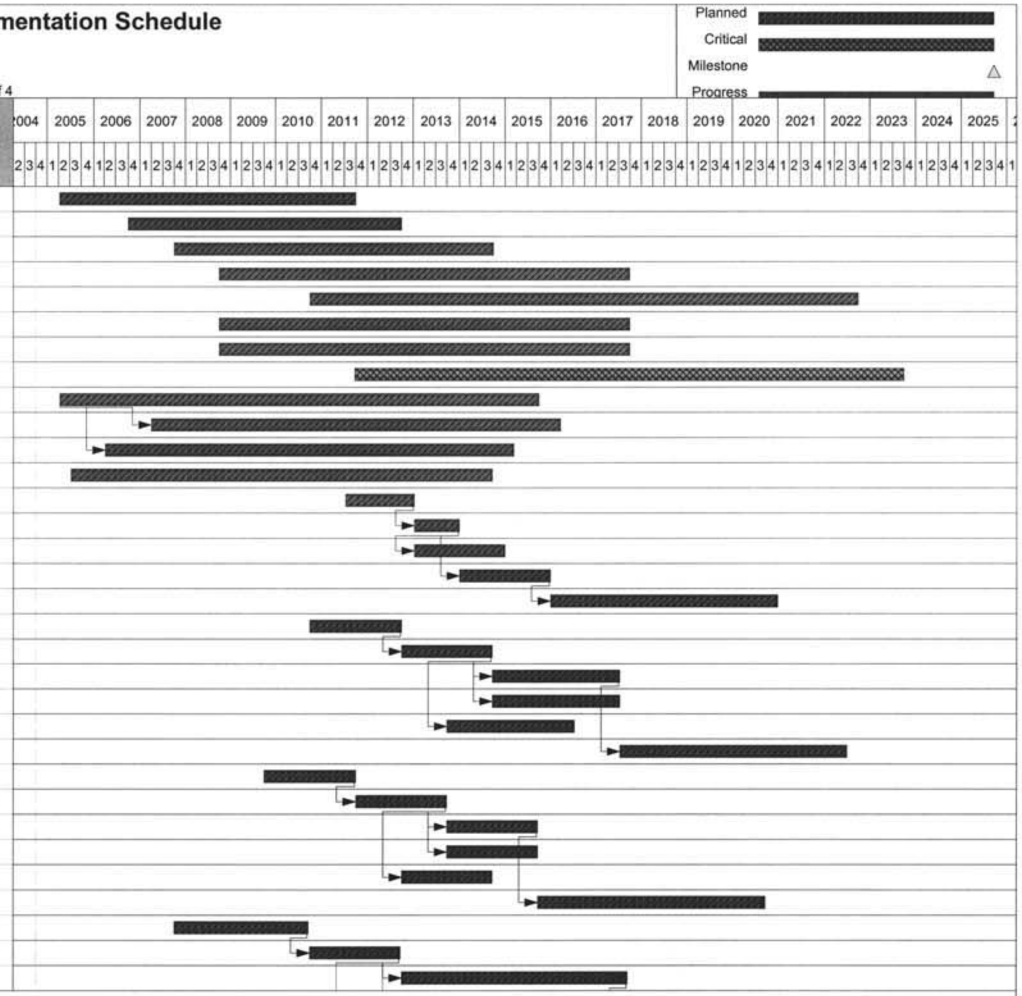


Table 2-17c. The LCA Plan Implementation Schedule

Project:	101204
Time Now:	10/01/04
Start:	10/01/04
Finish:	09/29/23
Run:	10/15/04

The LCA Plan Implementation Schedule

Planned
Critical
Milestone
Progress

3 of 4

ID	Activity Desc.	Duration	Early Start	Early Finish
M11C2	Small Diversion at Convent/Blind River E&D, S&A	1300d	09/24/12	09/15/17
M11C3	Small Diversion at Convent/Blind River RE	1300d	09/26/11	09/16/16
M11C4	Small Diversion at Convent/Blind River Monitoring	1300d	09/18/17	09/09/22
N12A	Increase Amite River Influence by Gapping Bank (SP1)	390d	10/01/07	03/27/09
N12B	Increase Amite River Influence PED	390d	03/30/09	09/24/10
N12C	Increase Amite River Influence Construction	390d	09/27/10	03/23/12
N12C2	Increase Amite River Influence E&D, S&A	390d	09/27/10	03/23/12
N12C3	Increase Amite River Influence RE	390d	09/28/09	03/25/11
N12C4	Increase Amite River Influence Monitoring	1300d	03/26/12	03/17/17
O13A	Medium Diversion at Whites Ditch (SP1)	780d	10/01/08	09/27/11
O13B	Medium Diversion at Whites Ditch PED	520d	09/28/11	09/24/13
O13C	Medium Diversion at Whites Ditch Construction	1300d	09/25/13	09/18/18
O13C2	Medium Diversion at Whites Ditch E&D, S&A	1300d	09/25/13	09/18/18
O13C3	Medium Diversion at Whites Ditch RE	1300d	09/26/12	09/19/17
O13C4	Medium Diversion at Whites Ditch Monitoring	1300d	09/19/18	09/12/23
P14A	Gulf Shore. Stabilization at Pt. Au Fer Island (SP3)	484d	10/01/09	08/09/11
P14B	Gulf Shore. Stabilization at Pt. Au Fer Island-PED	780d	08/10/11	08/05/14
P14C	Gulf Shore. Stabilization at Pt. Au Fer Is. Construction	352d	08/06/14	12/10/15
P14C2	Gulf Shore. Stabilization at Pt. Au Fer Is. E&D, S&A	352d	08/06/14	12/10/15
P14C3	Gulf Shore. Stabilization at Pt. Au Fer Is. RE	352d	08/07/13	12/11/14
P14C4	Gulf Shore. Stabilization at Pt. Au Fer Is. Monitoring	1300d	12/11/15	12/03/20
Q15A	Convey Atch. River to Terrebonne Marsh via Small Div.	630d	10/01/07	02/26/10
Q15B	Convey Atch. River to Terrebonne Marsh-PED	520d	03/01/10	02/24/12
Q15C	Convey Atch. River to Terrebonne Marsh-Construction	1560d	02/27/12	02/16/18
Q15C2	Convey Atch. River to Terrebonne Marsh-E&D S&A	1672d	02/27/12	07/24/18
Q15C3	Convey Atch. River to Terrebonne Marsh-RE	1672d	02/28/11	07/25/17
Q15C4	Convey Atch. River to Terr. Marsh Monitoring	1300d	02/19/18	02/10/23
R04A	Modification to Caernarvon Div (SP1) DD	520d	10/03/05	09/28/07
R04B	Modification to Caernarvon PED	520d	10/01/07	09/25/09
R04C	Modification to Caernarvon Div Construction	1040d	09/28/09	09/20/13
R04C2	Modification to Caernarvon Div E&D, S&A	1040d	09/28/09	09/20/13
R04C3	Modification to Caernarvon Div RE	1040d	09/29/08	09/21/12

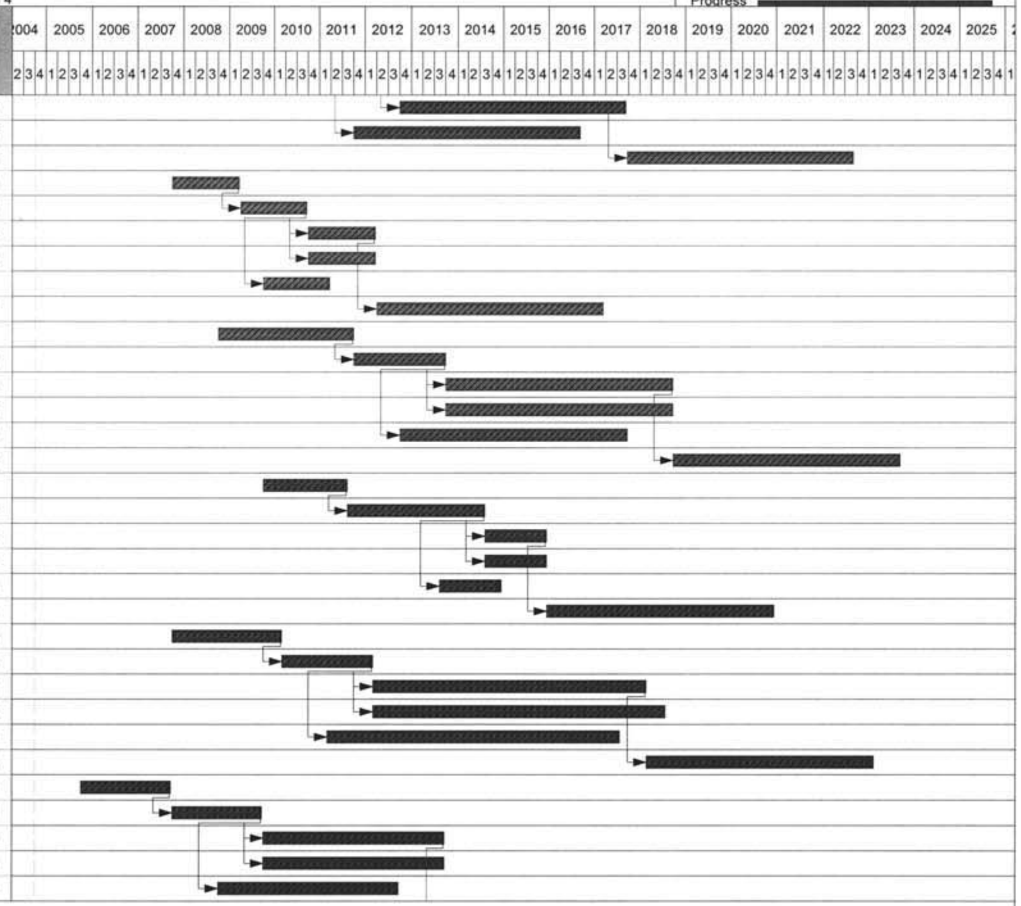


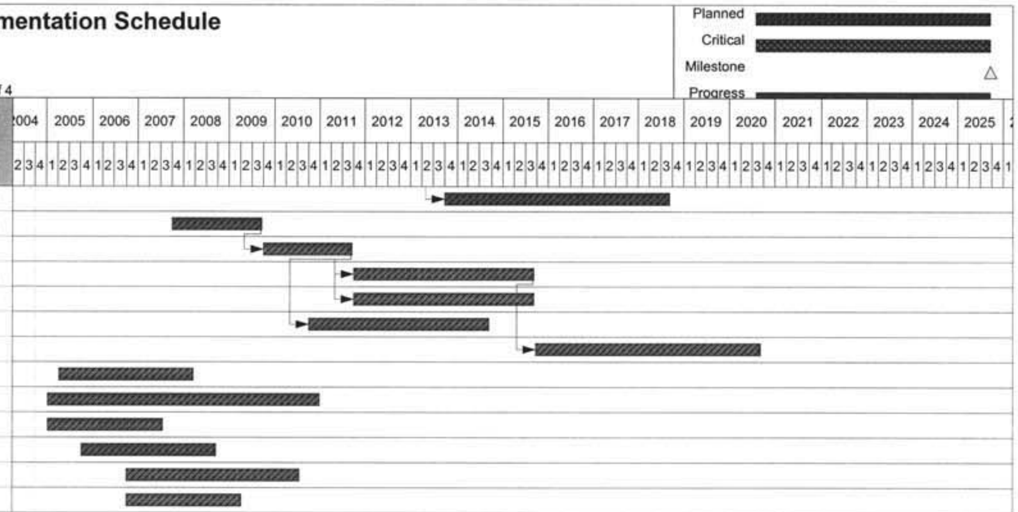
Table 2-17d. The LCA Plan Implementation Schedule

Project:	101204
Time Now:	10/01/04
Start:	10/01/04
Finish:	09/29/23
Run:	10/15/04

The LCA Plan Implementation Schedule

4 of 4

ID	Activity Desc.	Duration	Early Start	Early Finish
R04C4	Modification to Caernarvon Div Monitoring	1300d	09/23/13	09/14/18
S05A	Mod. to Davis Pond Div. for Increased Sed.SP2 DD	520d	10/01/07	09/25/09
S05B	Mod. to Davis Pond Div. for Increase Sed. PED	520d	09/28/09	09/23/11
S05C	Modification to Davis Pond Diversion Construction	1040d	09/26/11	09/18/15
S05C2	Modification to Davis Pond Diversion E&D, S&A	1040d	09/26/11	09/18/15
S05C3	Modification to Davis Pond Diversion RE	1040d	09/27/10	09/19/14
S05C4	Modivication to Davis Pond Div. Monitoring	1300d	09/21/15	09/11/20
TLS1	Mississippi River Hydrodynamic Study	780d	04/04/05	03/28/08
TLS2	Third Delta (SP2 and 3)	1560d	01/10/05	12/31/10
TLS3	Upper Atchafalaya Basin Study w/Mod Old Riv Cont Struct Scm	660d	01/10/05	07/20/07
TLS4	Chenier Plain Freshwater Mgt. and Allocation Reassess. (SP4)	780d	10/03/05	09/26/08
TLS5	Miss. River Delta Mgt. Study (SP1 & 2)	990d	10/02/06	07/16/10
TLS6	Acadiana Bay Estuarine Restoration (SP3)	660d	10/02/06	04/10/09



2.8.3. Near-Term Critical Restoration Features

2.8.3.1 Cost Effectiveness of the Near-term Critical Component of the LCA Plan

Following the identification of the critical near-term features to be implemented in the near-term restoration effort the ecologic models were run in each subprovince. The specific purpose of this modeling effort was to enable the cost effectiveness of the near-term critical features of the LCA Plan to be comparatively assessed relative to the larger frame works from which they had been developed. With the existing cost information and the benefit output for the LCA Plan in each subprovince a comparison of the cost effectiveness of the LCA Plan versus the previously analyzed coast wide frameworks was made. The overlaying of the LCA Plan on the identified cost effective frontier indicates that three coast wide frameworks previously deemed to be cost effective would be eliminated from the frontier. The comparison of the LCA Plan versus these frameworks is provided in **table 2-18**. The effected coastwide frameworks are shaded in the table.

Table 2-18.
LCA Plan versus Final Array of Coast Wide Frameworks
Forming the Cost Effective Frontier

Plan	Subprovince Framework Codes	Average Annual Benefits*	Average Annual Costs
0000	No Action	0	$ -
1000	S1R1	219	22,910,914
2000	S1R2	1074	24,350,598
5000	S1M2	1873	32,838,902
7000	S1E1	1945	55,021,432
5010	S1M2, S3R1	1987	70,438,353
7010	S1E1, S3R1	2059	92,620,883
2100	S1R2, S2R1	2185	113,555,259
LCA Plan		**2865**	**55,921,000**
5100	S1M2, S2R1	2984	122,043,563
7100	S1E1, S2R1	3056	144,226,093
5110	S1M2, S2R1, S3R1	3098	159,643,014
10130	S1-3 N3*	3134	179,073,919
7110	S1E1, S2R1, S3R1	3170	181,825,544
7410	S1E1, S2M1, S3R1	3182	207,599,025
7002	S1E1, S2E3, S3M1	3202	542,511,742

**Based on a composite of land building, habitat suitability, and nitrogen removal.*

A comparison of the cost effectiveness of the LCA Plan versus the final array of coast wide frameworks from which the LCA Plan was derived shows that the LCA Plan produces a lesser magnitude of output. However, the efficiency of the LCA Plan is comparable to that of the larger plans in the final array. The comparison of the LCA Plan and the final array of coast wide frameworks is presented in **table 2-19** and **figure 2-17.**

Table 2-19.
LCA Plan and Final Array of Coast Wide Frameworks

Plan	Subprovince Framework Codes	Average Annual Benefits ([1])	Average Annual Costs
LCA Plan		**2865**	**$ 55,921,000**
5610	S1M2, S2M3, S3R1	3094	171,479,754
5110	S1M2, S2R1, S3R1	3098	159,643,014
5410	S1M2, S2M1, S3R1	3110	185,416,495
10130	S1-3 N3*	3134	179,073,919
7610	S1E1, S2M3, S3R1	3166	193,662,284
7410	S1E1, S2M1, S3R1	3182	207,599,025
7002	S1E1, S2E3, S3M1	3202	542,511,742

*Note: Plan developed by modification of plan 5110.
([1]) **Based on a composite of land building, habitat suitability, and nitrogen removal.*

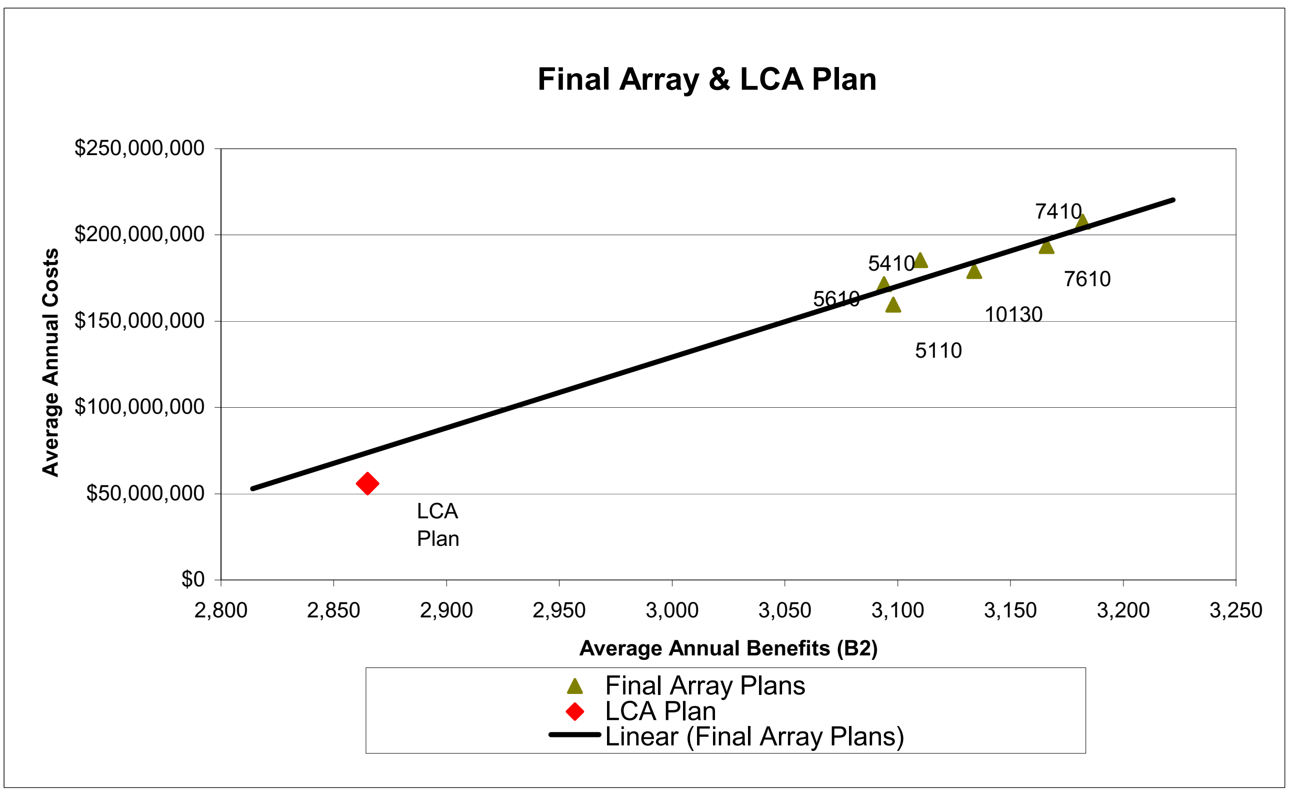


Figure 2-17. Effectiveness of the LCA Plan Relative to the Final Array of Coast Wide Frameworks

The ecologic model output for land building estimates that the plan would offset approximately 62.5 percent of the 462,000 acres projected to be lost within the coast under the no action alternative. The estimated land building for Subprovince 1 exceed projected no action losses. In Subprovinces 2 & 3 the models estimated that the LCA Plan prevented almost 50 percent of the expected losses in each basin. These estimates do not include any projects in Subprovince 4.

A comparison of the habitat suitability projected by the ecologic model for the LCA Plan indicates that increases in overall suitability in habitat for lower and moderate salinity species should generally occur in the Deltaic Plain subprovinces relative to no action. Subprovince 1 is an exception where lower salinity species are estimated to experience a slight decline in habitat with the LCA Plan, which is a reversal in trend as compared to the coast wide framework effects. This reversal is also apparent for moderate salinity species in Subprovince 1 with a negative habitat trend being reflected by the coast wide frameworks. In Subprovince 2, the coast wide frameworks project a slightly higher improvement for lower salinity species than with the LCA Plan. In Subprovince 3, there is no difference in projected trends from the LCA Plan to the coast wide frameworks.

For higher salinity species, the projected trends for all three subprovinces indicate slight to moderate decline in habitat suitability. The comparison of the effect of the LCA Plan versus the coast wide frameworks indicates that the habitat decline would be somewhat reduced for the LCA Plan. The models estimate that the largest effects would occur in these saline habitats. The potential declines of approximately 35 percent in these habitat types are heavily influenced by oyster habitat suitability factors.

The ecologic model also estimates the capability of restoration plans for nitrogen removal from Mississippi River flows. A target for this effectiveness is expressed as a fraction of 30 percent of the annual nitrogen load transported by the river. In relation to the coast wide frameworks, the potential of the LCA Plan to meet this objective is reduced due to the exclusion of larger-scale diversions from the near-term restoration plan.

Although the model results indicate that the LCA Plan would offset roughly 62.5 percent of the projected land loss in the future, significant need still exists to offset the past loss of approximately 1.2 million acres and subsequent reduction in overall ecosystem quality.

2.8.3.2 Conditional authority for implementation of certain near-term critical restoration features

Feasibility-level decision documents would be developed for each of the initial five near-term critical restoration features. These feasibility-level decision documents would document planning; engineering and design; real estate analyses; and supplemental requirements under the NEPA. It is recommended that Congress authorize implementation of the five near-term restoration features described below, subject to review and approval of the feasibility-level decision documents by the Secretary of the Army.

The feature descriptions below explain the justification for the requested conditional authorization for the initial five near-term critical restoration features. All of these features have a basis in cost effectiveness and in their value in addressing critical natural and human ecological needs. These five critical near-term features present a range of effects essential for success in restoring the Louisiana coast. The benefits provided by these features include the sustainable reintroduction of riverine resources, rebuilding of wetlands in areas at high risk for future loss, the preservation and maintenance of critical coastal geomorphic structure, and perhaps most importantly, the preservation of critical areas within the coastal ecosystem, and the opportunity to begin to identify and evaluate potential long-term solutions.

Based on a body of work both preceding and including this study effort, the PDT produced an estimate of average annual costs and benefits for these five features. Benefits were estimated during previous investigations of these features using a community based Habitat Evaluation Procedure (HEP) model developed by the USFWS specifically for the CWPPRA program. This model was entitled the Wetland Value Assessment (WVA) and was geared toward optimal species common parameters over a range of habitats. The model is driven by input based on multi-user professional judgment supported by available habitat data and user observation. The users must specifically prescribe the area and level of expected effect. This model expands upon professional judgment by formalizing a consensus, and standardizing methodology. The model does not mathematically extrapolate biologic response over the defined spatial extent of the project area in the manner of the desktop or a numeric model. In this regard, the WVA has some limitation in projecting beneficial output. While the desktop model is capable of capturing far reaching secondary effects related to altered hydrology or riverine input transported through a larger system, the WVA can be limited by the user defined areas, and estimated levels, of effect.

Composite information based on WVA output for these features shows that average annual environmental output for this conditionally authorized feature package would be on the order of 22,000 habitat units (HU) at an average annualized cost of $2,700 per unit provided. Summaries of the five near-term critical features presented for conditional authorization are presented on the following pages. Detailed descriptions and background information for these five features is provided in attachment 4 to the Main Report.

2.8.3.2.1 *Mississippi River Gulf Outlet (MRGO) environmental restoration features*

The Lake Borgne estuarine complex is deteriorating and recent analysis indicates that the rate of wetland loss in the area is accelerating. Rapid action is required to protect the integrity of the southern Lake Borgne shoreline and to prevent continued erosion of the Mississippi River Gulf Outlet (MRGO) channel banks from ocean going vessel wakes. Additional ecosystem restoration features are required to address serious ecological problems developing in the surrounding parts of the estuary. Without action, critical landscape components that make up the Lake Borgne estuary would be lost and future efforts to restore other parts of the ecosystem would be much more difficult and expensive if not impossible.

Construction and maintenance of the MRGO caused widespread wetland loss and damage to estuarine habitats from the outer barrier islands in the lower Chandeleur chain up to cypress forests and tidal fresh marshes in the western reaches of the Lake Borgne Basin. During construction of the MRGO, dredging and filling destroyed more than 19,000 acres of wetlands, and an important hydrologic boundary was breached when the channel cut through the ridge at Bayou La Loutre.

After the MRGO was completed, significant habitat shifts occurred because the impacted area converted to a higher salinity system with the influx of saltwater through ridges and marsh systems that were severed or destroyed during channel construction. Continued operation of the MRGO results in high rates of shoreline erosion from ship wakes, which destroy wetlands and threatens the integrity of the Lake Borgne shoreline and adjacent communities, infrastructure, and cultural resources. In addition, severe erosion of the MRGO channel continues to facilitate the transition of the upper Pontchartrain Basin estuary toward a more saline system.

Annual erosion rates in excess of 35 feet along the north bank of the MRGO result in the direct loss of approximately 100 acres of shoreline brackish marsh every year and additional losses of interior wetlands and shallow ponds as a result of high tidal ranges and rapid water exchange through the modified watercourse system. These vegetated habitats and shallow waters are important for estuarine biological resources and serve as critical habitat for the threatened Gulf sturgeon.

Erosion and saltwater intrusion are also impacting ridge habitat that is important for mammals, reptiles, and birds. The highest rates of erosion in the area occur along the north bank of the MRGO channel. The southern shoreline of Lake Borgne is eroding at approximately 15 feet per year resulting in the loss of 27 acres (10.9 ha) of wetlands per year. Continuing erosion along the channel and the shoreline of Lake Borgne is threatening to breach the lake/marsh rim, which would result in the coalescence of the two water bodies. A breach would accelerate marsh loss.

This near-term restoration feature involves the construction of shoreline protection measures, such as rock breakwaters, along the north bank of the MRGO and along important segments of the southern shoreline of Lake Borgne, as well as the investigation of various environmental restoration strategies requested in response to public concerns over the proposed plan to stabilize the MRGO navigation channel. The natural ridges along these selected shoreline segments are in danger of breaching in the very near future because of ship wakes along the channel and erosion from wind-driven waves along the lakeshore. Once these ridges are breached, the wetlands protected by these ridges become vulnerable to natural and man-made erosive forces that will quickly work to degrade the wetlands. Strategic placement of similar protective breakwaters has been effectively used along the MRGO in other locations to prevent bankline retreat and to protect large areas of estuarine wetlands from further erosion and degradation. The breakwaters may also facilitate future wetland creation using dedicated dredging and/or beneficial use of dredged material by serving as containment and protection for the restored wetlands. Additional ecosystem restoration features including marsh creation, freshwater introduction, barrier island restoration, and channel modification will be investigated to develop a suite of measures to stabilize and maintain important estuarine components.

The specific features proposed as part of the near-term MRGO environmental restoration plan include:

- Construct 23 miles (37 km) of shoreline protection using rock breakwaters to prevent high rates of erosion that are occurring along the north bank of the MRGO.

- Construct 15 miles (24.2 km) of rock breakwaters to protect critical points along the southern shoreline of Lake Borgne that are in peril of breaching in the near future.

These features would prevent the loss of 6,350 acres (2,572 ha) of marsh over the next 50 years. The estimated cost for designing and constructing critical rock breakwaters along the MRGO and selected sections of the southern Lake Borgne shoreline is $108.27 million (including monitoring). Details of this cost estimate are provided in the **tables 2-21** and **2-22**:

Table 2-20. Summary of Costs for MRGO Environmental Restoration Features (June 2004 Price Level)

Lands and Damages	$	4,214,000
Elements:		
Bank Stabilization	$	80,000,000
Monitoring	$	842,000
First Cost	$	85,056,000
Feasibility-Level Decision Document	$	5,400,000
Preconstruction Engineering and Design (PED)	$	3,600,000
Engineering and Design (E&D)	$	4,614,000
Supervision and Administration (S&A)	$	9,600,000
Total Cost	**$**	**108,270,000**

Table 2-21. MRGO Environmental Restoration Features
FEDERAL AND NON-FEDERAL COST BREAKDOWN
(June 2004 Price Level)

Item	Federal	Non-Federal	Total
Decision Document (50%Fed-50%NFS)	$ 2,700,000	$ 2,700,000	$ 5,400,000
PED (65%Fed-35%NFS)	$ 2,340,000	$ 1,260,000	$ 3,600,000
LERR&D (100% NFS)	$ -	$ 4,214,000	$ 4,214,000
Ecosystem Restoration (65%Fed-35%NFS)	$ 54,739,100	$ 25,260,900	$ 80,000,000
Engineering and Design (E&D) (65%Fed-35%NFS)	$ 2,999,100	$ 1,614,900	$ 4,614,000
Supervision and Administration (S&A) (65%Fed-35%NFS)	$ 6,240,000	$ 3,360,000	$ 9,600,000
Monitoring (65%Fed-35%NFS)	$ 547,300	$ 294,700	$ 842,000
Total Construction	**$ 66,865,500**	**$ 36,004,500**	**$ 102,870,000**
TOTAL COST	**$ 69,565,500**	**$ 38,704,500**	**$ 108,270,000**
Cash Contribution	*$ 69,565,500*	*$ 31,790,500*	

In addition to these specific construction items, details of additional ecosystem restoration features would be developed during a study phase for purposes of estimating costs and benefits and for selecting the best set of projects to attain the ecosystem restoration goals for the area. This study effort would be conducted under the modification of the existing structures portion of the LCA proposed authorization. Under this approach, the MRGO channel is considered a structure for purposes of evaluating potential modifications to improve the environment.

Under this plan, large amounts of estuarine marshes would be protected from further shoreline erosion and other areas would be improved for the long-term benefit of the environment. In addition, other restoration features will be investigated that produce environmental benefits following the sequence established in the Coast 2050 plan to preserve wetlands and maintain the estuarine gradients established by the surrounding marshes. These habitats are significant for commercial and recreational fisheries as well as wildlife, and these areas serve as critical habitat for the threatened Gulf sturgeon.

The most important area of uncertainty associated with the near-term proposal is the future of the MRGO navigation channel as a deep draft-shipping route. A study is currently underway to reevaluate the economic benefits to the Nation of maintaining the channel. The scope of the reevaluation study covers a number of different alternative depth modifications and implementation timeframes for channel authorization changes. The outcome of that study has not been determined and, thus, the future status of the channel is unknown at this time. The possibility exists that some time in the future the status of the channel could be changed through a USACE study recommendation and a Congressional action to deauthorize the shipping canal. However, while some of the ecosystem losses occurring in the area are directly associated with the operation of the navigation channel, the need for shoreline protection on Lake Borgne and the channel will remain regardless of the future status of the channel. The need will remain because the background factors in Louisiana wetland losses will continue and some shallow draft navigation will likely continue to use the area waterways.

2.8.3.2.2 ***Small diversion at Hope Canal***

The cypress-tupelo swamps south of Lake Maurepas represent an accumulation of decades of plant production and associated ecological complexity. Much (arguably, relatively more than even most other coastal ecosystems in Louisiana) will be lost if this ecosystem is degraded beyond the ability to restore it. Given the temporal considerations associated with replacing long-lived tree species, preventing the loss of such trees is preferable from both economic and ecological standpoints.

The ongoing degradation of the Maurepas Swamp can be attributed to two types of factors: the first being the relatively constant stress associated with the lack of riverine input and prolonged inundation, and the second being the effects of stochastic events, most notably increased salinities. A qualitative estimate of the ecosystem losses that could be prevented by contingent authorization must consider both types of these factors.

The ongoing, constant deterioration of the Maurepas Swamp results in reduced tree productivity and health, increased tree mortality, decreased soil integrity, and increased relative subsidence. At this same time, stochastic events (particularly salinity increases) have the potential to dramatically increase tree mortality, while further stressing the remaining trees. Delaying project implementation would result in a continuation of the constant ecosystem decline, while also exposing the existing ecosystem to the additional risks associated with increased salinities and other difficult to predict events. Therefore, under any scenario, expediting implementation of the Hope Canal project would prevent a range of potential adverse effects. Again, because the higher end of this range would represent unpredictable events, it would not be possible to accurately predict the full possible extent of such losses.

The potential adverse effects discussed above would include decreased habitat for important avian species (most notably the bald eagle) and could also adversely affect the populations of a variety of indigenous species, such as crawfish, alligator snapping turtles, blue crab, and channel catfish. Additionally, such losses would also contribute to an overall decline in swamp health, as measured by soil integrity, substrate elevation, and vegetative health and resilience.

The effectiveness of the Hope Canal project depends in large part upon enhancing the health and productivity of the existing trees, which would play a major role in restoring soil integrity and counteracting subsidence. As discussed above, delaying action on the Hope Canal project would result in increased tree mortality and decreased health in the remaining trees. It is very difficult to quantify the number of individual trees that would die or become severely stressed, but it is certain that the system as a whole will suffer without action. A delay would, therefore, most likely reduce the effectiveness of this restoration effort and/or require increased restoration inputs to achieve the same level of benefits.

Contingent authorization of the Hope Canal project is an appropriate and necessary way to meet the critical needs discussed above. Specifically, expediting the authorization process for this project has the potential to reduce tree mortality and decline in the overall health of the swamp; minimize exposure to stochastic risks, particularly increased salinities; reduce potential impacts to populations of indigenous fish and wildlife species; and minimize restoration costs and maintain restoration effectiveness.

The specific features proposed as part of the near-term Hope Canal Reintroduction plan include:

- Construct 2 10-foot x 10-foot box culverts in the Mississippi River levee with the invert set at an elevation to assure capability of essentially year-round water diversion.
- Build a receiving pond/settling basin with 100-foot x 100-foot dimensions, reinforced with 20 inches of riprap at the outfall of the culverts to slow velocities and remove heavy sand.
- Excavate a new leveed channel from the existing southern terminus of Hope Canal to the proposed reintroduction structure in the Mississippi River levee.
- Enlarge the cross section of Hope Canal to a width of 50 feet to accommodate the reintroduced river water. This channel would be a total of 27,500 feet long and run from the river to I-10.
- Implement outfall management measures to insure the water gets into the swamp.
- Install navigable constrictions in Hope Canal and gap an abandoned railroad embankment along Hope Canal north of I-10.

The Hope Canal project would restore approximately 36,000 acres (14,580 ha) of swamp. The estimated cost for designing and constructing the Hope Canal Reintroduction feature is $70.513 million (including monitoring). Details of this cost estimate are provided in the **tables 2-22** and **2-23**:

Table 2-22 Summary of Costs for the Small Diversion at Hope Canal (June 2004 Price Level)

Lands and Damages	$	26,383,000
Elements:		
Relocations	$	22,384,000
Channels and Canals	$	4,125,000
Diversion Structures	$	6,520,000
Monitoring	$	594,000
First Cost	$	60,006,000
Feasibility-Level Decision Document	$	3,568,000
Preconstruction Engineering and Design (PED)	$	2,182,000
Engineering and Design (E&D)	$	1,189,000
Supervision and Administration (S&A)	$	3,568,000
Total Cost	**$**	**70,513,000**

Table 2-23. Small Diversion at Hope Canal FEDERAL AND NON-FEDERAL COST BREAKDOWN (June 2004 Price Level)

Item	Federal	Non-Federal	Total
Decision Document (50%Fed-50%NFS)	$ 1,784,000	$ 1,784,000	$ 3,568,000
PED (65%Fed-35%NFS)	$ 2,182,000	$ -	$ 2,182,000
LERR&D (100% NFS)*	$ -	$ 48,767,000	$ 48,767,000
Ecosystem Restoration (65%Fed-35%NFS)	$ 10,645,000	$ (25,336,250)	$ 10,645,000
Engineering and Design (E&D) (65%Fed-35%NFS)	$ 1,189,000	$ -	$ 1,189,000
Supervision and Administration (S&A) (65%Fed-35%NFS)	$ 3,568,000	$ -	$ 3,568,000
Monitoring (65%Fed-35%NFS)	$ 594,000	$ -	$ 594,000
Total Construction	**$ 18,178,000**	**$ 23,430,750**	**$ 66,945,000**
TOTAL COST	**$ 19,962,000**	**$ 25,214,750**	**$ 70,513,000**
Cash Contribution	*$ 47,082,250*	*$ (25,336,250)*	

*For the conditionally authorized feature, Small Diversion at Hope Canal, LERR&D exceeded 35% of the total project cost by $25,336,250, which is reimbursed to the non-federal sponsor.

To preserve swamps in the long-term, conditions must be reestablished that both allow survival of existing cypress and tupelo trees and allow at least periodic reproduction and recruitment of seedlings. In the Maurepas Swamp, non-stagnant water, accretion, and freshening are all needed to achieve these goals. From the perspective of sustainable ecosystem management, it is believed that implementation of a reintroduction project of appropriate size into the Maurepas Swamp is essential for bringing the area back toward environmental sustainability. Implementation of the proposed reintroduction would greatly increase flow through the project area, which would provide constant renewal of oxygen- and nutrient-rich waters to the swamps. (It is important to note that the proposed alternative would be operated such that reintroductions are reduced or stopped when climate and soil conditions are conducive to tree regeneration).

Benefits of the Hope Canal project would include measurable increases in productivity, which would help build swamp substrate and balance subsidence, as well as increases in growth of trees, reduced mortality, and an increase in soil bulk density. As accretion improves, there also is expected to be an increase in recruitment of new cypress and tupelo trees, required for long-term sustainability of the swamp. Anticipated sediment benefits to the swamp include direct contribution to accretion, as well as contribution to biological productivity through the introduction of sediment-associated nutrients, which also contributes to production of substrate. The sediment loading to the target swamps from the Hope Canal reintroduction is conservatively estimated to be >1,000 $g/m^2/yr$, or about twice the estimated quantity needed to keep up with subsidence.

The Hope Canal project has already been the subject of interagency review, numerous planning processes, considerable public review, and a range of environmental and engineering analyses. This review process has helped identify and address a number of potential questions/concerns, such as whether river reintroduction could cause flooding. While more information and evaluation will be needed to fully answer such questions, the information available to date indicates that such issues will either not occur or, if they could occur, are manageable and do not render the project infeasible or too risky. With respect to flooding in particular, the increased channel capacity in Hope Canal should provide greater ability to remove storm water from the existing drainage system, and the operation plan for the reintroduction project would be developed to accommodate such a use.

The Hope Canal project would offer an excellent opportunity to capitalize on existing environmental and engineering information to provide near-term environmental benefits to an area of critical need. Accordingly, it should be included in the contingent authorization category for the LCA Study.

2.8.3.2.3 *Barataria Basin barrier shoreline restoration*

The Louisiana barrier islands and shorelines are almost entirely uninhabited but are an essential ecosystem to the Louisiana coastal area since they include wetland habitats, essential fish habitat, and have high fish and wildlife value. The Louisiana barrier islands also protect interior coastal wetlands, which also have high fish and wildlife value within the Louisiana coast area.

The accelerated loss of Louisiana's coastal wetlands has been ongoing since at least the early 1900s with commensurate deleterious effects on the ecosystem and possible future negative impacts to the economy of the region and the Nation (USACE 2004 – Main Report). Contributing to these deleterious effects is the collapse of the Louisiana barrier islands and gulf coast shorelines. This Louisiana coastal area restoration feature is to restore or re-build the natural ecological function of the two coastal barrier shorelines, known as the Caminada Headland and Shell Island reaches.

The average rate of long-term (greater than 100 years) shoreline change along the Louisiana coast is a retreat of 19.9 ft/yr. The average short-term (less than 30 years) rate of shoreline change is a retreat of 30.9 ft/yr (USACE 2004 – Appendix D.3). Of the 505 miles of Louisiana gulf shoreline, 484 miles (96 percent) are eroding. The Barataria Basin Barrier Shoreline Restoration Project is one of three barrier island projects in the LCA Plan. All three of these barrier island projects are important; however, the Barataria Barrier Shoreline Restoration is considered critical due to the greatly degraded state of this shoreline and its key role in protecting and preserving larger inland wetland areas and bays. If this fragile area is not addressed quickly, restoration would be far more difficult and costly.

The Barataria Basin Barrier Island Restoration feature addresses critical ecological needs and would sustain essential geomorphic features for the protection of Louisiana's coastal wetlands and coastal infrastructure. The project is synergistic with future restoration by maintaining or restoring the integrity of Louisiana's coastline, upon which all future coastal restoration is dependent. The design and operation of the feature would maintain the opportunity for and support the development of large-scale, long-range comprehensive coastal restoration. The feature would also support the opportunity for resolution of scientific and technical uncertainties through incorporation of demonstration features and/or adaptive management.

The specific features proposed as part of the near-term Barataria Basin Barrier Island Restoration plan include:

<u>Caminada Headland</u>

- Dredge and place 9 to 10 million cubic yards of sand from Ship Shoal along 13 miles of shoreline to create a dune approximately 6 feet high and a 1,000-foot wide shoreward berm. Plant the dune with native varieties of bitter panicum and sea oats for stabilization.
- Remove thirteen existing breakwaters that are failing.
- Approximately 2 million cubic yards of sand would be placed about every 10 years to periodically restore the dune and berm.
- Dredge and place about 6 million cubic yards of material to create a marsh area about 5 miles long and up to 1,200 feet wide. The created marsh would be planted with native vegetation, such as smooth cordgrass.
- Nourish existing eroding marsh in the area with a thin layer of dredged material.

Shell Island (west)

- Dredge and place 3.4 million cubic yards of material to create 139 acres of dune and berm and 74 acres of marsh.
- Plant the dune with native varieties of bitter panicum and sea oats for stabilization.
- Plant the marsh with smooth cordgrass, also a native variety.

Shell Island (east)

- Dredge and place 6.6 million cubic yards of material to create 223 acres of dune and berm and 191 acres of marsh. Contain material with geotubes on the gulf side and earthen dike on the bay side.
- Plant the dune with native varieties of bitter panicum and sea oats for stabilization.
- Plant the marsh with smooth cordgrass, also a native variety.

The Caminada Headland component would preserve 640 acres of dune and berm over the next 50 years and 1,780 acres of saline marsh. The Shell Island component would preserve 147 acres of barrier island habitat over the next 50 years. The estimated cost for designing and constructing these barrier shoreline restoration features is $247.204 million (including monitoring). Details of this cost estimate are provided in the **tables 2-24** and **2-25**:

Table 2-24. Summary of Costs for Barataria Basin Barrier Shoreline Restoration (June 2004 Price Level)

Lands and Damages	$	15,558,000
Elements:		
Beach Replenishment	$	181,000,000
Monitoring	$	1,966,000
First Cost	$	198,524,000
Feasibility-Level Decision Document	$	10,200,000
Preconstruction Engineering and Design (PED)	$	6,800,000
Engineering and Design (E&D)	$	9,960,000
Supervision and Administration (S&A)	$	21,720,000
Total Cost	**$**	**247,204,000**

Table 2-25. Barataria Basin Barrier Shoreline Restoration
FEDERAL AND NON-FEDERAL COST BREAKDOWN
(June 2004 Price Level)

Item	Federal	Non-Federal	Total
Decision Document (50%Fed-50%NFS)	$ 5,100,000	$ 5,100,000	$ 10,200,000
PED (65%Fed-35%NFS)	$ 4,420,000	$ 2,380,000	$ 6,800,000
LERR&D (100% NFS)	$ -	$ 15,558,000	$ 15,558,000
Ecosystem Restoration (65%Fed-35%NFS)	$ 127,762,700	$ 53,237,300	$ 181,000,000
Engineering and Design (E&D) (65%Fed-35%NFS)	$ 6,474,000	$ 3,486,000	$ 9,960,000
Supervision and Administration (S&A) (65%Fed-35%NFS)	$ 14,118,000	$ 7,602,000	$ 21,720,000
Monitoring (65%Fed-35%NFS)	$ 1,277,900	$ 688,100	$ 1,966,000
Total Construction	**$ 154,052,600**	**$ 82,951,400**	**$ 237,004,000**
TOTAL COST	**$ 159,152,600**	**$ 88,051,400**	**$ 247,204,000**
Cash Contribution	*$ 159,152,600*	*$ 67,393,400*	

The Caminada Headland component of the Barataria Basin Barrier Shoreline Restoration should be constructed at the earliest possible date and include ecosystem restoration of the dune and berm as well as marsh creation. The overall goal of this feature is to maintain this headland reach, which would sustain significant and unique coastal habitats, help preserve endangered and threatened species, continue to transport sand to Grand Isle, and protect Port Fourchon and the only hurricane evacuation route available to the region.

The Shell Island component of the Barataria Basin Barrier Shoreline Restoration should be constructed at the earliest possible date and include beach restoration by use of containment to rebuild a vital link in the Louisiana barrier shoreline system. The overall goal is to prevent the intrusion of the Gulf of Mexico into the interior bays and marshes, which threatens fisheries and the regional ecology. The project would also help restore natural sand transport along this reach of the coast supporting the adjacent regional shorelines and various shoreline habitats. Numerous infrastructure elements such as highways, levees, ports, and oil and gas facilities located along the rim of the inland bays would incidentally benefit from this ecologic restoration.

The coastal resources at risk for the Barataria Basin Barrier Shoreline Restoration feature and the level of investigation in this area undertaken to date provides a high level of certainty in the appropriateness of the restoration feature and the range of alternative configurations that should be addressed in a final decision document. This project must be undertaken with a strong adaptive management approach due to the uncertainties of coastal processes and response to restoration. Monitoring- based project management would largely offset technical uncertainties. The current status of analyses and NEPA documentation also provides a high degree of confidence that the design and documentation for this restoration feature can be completed for approval and implementation on an expedited schedule.

2.8.3.2.4 *Small Bayou Lafourche reintroduction*

Bayou Lafourche occupies a central location in Louisiana's Deltaic Plain, between Terrebonne and Barataria Bays. This valuable estuarine complex is also Louisiana's most endangered, due in large part to the disruption of natural deltaic processes. Once a major distributary of the Mississippi River, Bayou Lafourche was a critical conduit for freshwater, nutrients, and sediment, which helped build and nourish marshes in the Barataria-Terrebonne estuary complex. Although flows down Bayou Lafourche declined as the river switched its course 800 to 1,000 years ago, the bayou continued to provide important riverine inputs until it was dammed in 1904 to alleviate flooding problems. While a limited amount of river flow (currently around 200 cfs) was subsequently restored to the bayou, there is an opportunity to use this natural distributary to increase freshwater, nutrient, and sediment inputs to coastal areas with critical restoration needs.

Approximately 2,000 years ago, the course of the Mississippi River began to occupy what is now Bayou Lafourche. This channel remained a primary distributary of the Mississippi River until about 800 to 1,000 years ago, when it was gradually replaced by the modern course of the river. While it was active, the Bayou Lafourche distributary built a large natural levee, with elevation ranging from over 20 feet NGVD near Donaldsonville, to approximately 1 foot near the mouth of the bayou.

In 1851 and 1858, discharge in Bayou Lafourche was measured at 6,000 to 11,000 cfs during high river stages. Thus, despite the shift in the river, Bayou Lafourche remained a major conduit by which freshwater, nutrients, and sediment were transported to coastal wetlands. During this time, the bayou was also extensively used for navigation.

Flows continued to decrease during the 19th century and, by 1887, a bar had developed at the head of the bayou, which restricted flow and navigation. This led to annual dredging by the USACE. Additionally, the natural levee along the bayou was not sufficient to protect settled areas from flooding, and plantation owners gradually built up levees along most of the length of the bayou. Despite these levees, flood problems along Bayou Lafourche began to overshadow the usefulness of the channel for navigation. In 1902, Federal approval was given to construct a temporary dam across the head of the bayou. The dam was completed in 1904. The intent was to replace this dam with a lock, to allow for navigation. However, the dam was subsequently replaced by the Mississippi River flood control levee.

In 1906, a new problem arose: salt-water intrusion was recorded at Bush Grove Plantation just south of Lafourche Crossing. Agricultural, industrial, and domestic users recognized that fresh water would be necessary for their communities to continue to thrive. Also, damming the bayou contributed to dramatic salinity increases in the Barataria-Terrebonne estuary system. Anecdotal information gives evidence of the dramatic changes that resulted from the increased salinities. By 1910, for example, oysters were found growing in areas around Leeville, and where orange orchards and rice fields had once flourished, saltwater seeped into the land, killing the oak groves and making the soil unsuitable for farming.

Responding to expanding industrial and residential demands, the Louisiana Legislature created the Bayou Lafourche Freshwater District in the 1950s. In 1955, a pump/siphon system with a capacity to reintroduce approximately 340 cfs was installed on the levee at Donaldsonville. No Federal funds were spent on that project. Because of channel constraints, this existing pump/siphon currently provides approximately 200 cfs of river water into the bayou. Approximately 80 percent of the current volume of water reintroduced to the bayou flows through the system, with approximately 20 percent being used for water supply (of which a relatively small amount is used for irrigation).

Today the bayou supplies fresh water to over 300,000 residents in four parishes: Ascension, Assumption, Lafourche and Terrebonne. In addition to residents and land-based businesses, Bayou Lafourche also provides potable water through Port Fourchon to offshore oil and gas facilities in the Gulf of Mexico. The bayou also provides aesthetic, recreation, drainage and navigation benefits to the numerous communities that have developed along its banks.

From 2000 to 2050, this estuary complex is predicted to lose approximately 231,000 acres of wetlands. This is 50 percent of the predicted loss in the entire state. In addition, approximately 465,000 acres have been lost in this complex over the past 50 years. The continued loss will further weaken an already stressed ecosystem that supports a wide range of resident and migratory animals. The highly diverse and numerous fish and shellfish populations in the complex would dramatically decline as land loss continues. In the future, there would be decreased habitat for neo-tropical migratory birds, furbearers, waterfowl, and threatened species such as the bald eagle.

Proposals to reconnect Bayou Lafourche as a restoration feature date back to at least 1992. At that time, coastal researchers from Louisiana State University’s Center for Coastal Energy and Environmental Resources (CCEER; Currently LSU School of the Coast and the Environment) crafted a report that included reconnection of the former distributary as an innovative alternative to help address the land loss crisis in the Louisiana coastal zone. In the November 1993 Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) Main Report and Environmental Impact Statement (EIS) submitted to the U.S. Congress by the Task Force, reintroduction of Mississippi River water via Bayou Lafourche was listed as a major strategy for both the Terrebonne and Barataria basins.

The specific features proposed as part of the near-term Bayou Lafourche Reintroduction plan include:

- Upgrading existing pump/siphon facility to operate at the full 340 cfs capacity and constructing a 660 cfs new pump/siphon facility.
- Improving channel capacity to 1,000 cfs by eliminating the existing fixed weir at Thibodeaux, dredging of 6.7 million cubic yards of material over about 55 miles of the channel within its existing banks. If the dredged sediments are clean, they will be

made available for local use and land application or sale. Any contaminated sediment will require special placement.

- Providing bank stability over three miles of the channel. The improved channel and bank stabilization would prevent flooding of bayou-side residents.
- Operating five monitoring stations to provide continuous information on water levels and other bayou conditions.
- Installing two adjustable weirs, one at Thibodeaux and another at Donaldsonville, to control water levels as necessary to eliminate current causes of bank instability, and to facilitate passage of storm runoff.
- Constructing a sediment trap at Donaldsonville to control siltation of the main channel and insure that flows are not impeded. This trap would be cleaned as needed.

As part of the CWPPRA process, the wetland benefits of the Bayou Lafourche project, with regard to providing habitat for a variety of fish and wildlife species, were calculated using Wetland Value Assessment (WVA) methodology. The benefit areas encompass 85,094 acres (nearly 49,000 acres of wetlands and 36,000 acres of water). Wetland benefits were determined primarily in terms of the projected reduction in marsh loss expected to occur as a result of the project. The mechanisms through which the diversion was expected to impact marsh loss in the seven areas were: (1) the reduction of salinity stress due to increased freshwater flows, and (2) the stimulation of organic production in emergent marshes as a result of the introduction of clay sediment and nutrients. Based on the 1998 WVA, it is estimated that at the end of 50 years there would be approximately 2,500 more acres of marsh than if the project had not been built. The WVA also credited this project with increasing submerged aquatic vegetation (SAV) that improves habitat for fish and waterfowl.

The estimated cost for designing and constructing the Bayou Lafourche Reintroduction is $144.116 million (including monitoring). Details of this cost estimate are provided in **tables 2-26** and **2-27**:

Table 2-26. Summary of Costs for Small Bayou Lafourche Reintroduction (June 2004 Price Level)

Lands and Damages	$	12,590,000
Elements:		
Relocations	$	14,720,000
Channels and Canals	$	52,156,000
Pumping Plants	$	16,230,000
Bank Stabilization	$	6,894,000
Monitoring	$	1,026,000
First Cost	$	103,616,000
Feasibility-Level Decision Document	$	13,500,000
Preconstruction Engineering and Design (PED)	$	9,000,000
Engineering and Design (E&D)	$	5,040,000
Supervision and Administration (S&A)	$	12,960,000
Total Cost	**$**	**144,116,000**

Table 2-27. Small Bayou Lafourche reintroduction FEDERAL AND NON-FEDERAL COST BREAKDOWN (June 2004 Price Level)

Item	Federal	Non-Federal	Total
Decision Document (50%Fed-50%NFS)	$ 6,750,000	$ 6,750,000	$ 13,500,000
PED (65%Fed-35%NFS)	$ 5,850,000	$ 3,150,000	$ 9,000,000
LERR&D (100% NFS)	$ -	$ 27,310,000	$ 27,310,000
Ecosystem Restoration (65%Fed-35%NFS)	$ 66,683,500	$ 8,596,500	$ 75,280,000
Engineering and Design (E&D) (65%Fed-35%NFS)	$ 3,276,000	$ 1,764,000	$ 5,040,000
Supervision and Administration (S&A) (65%Fed-35%NFS)	$ 8,424,000	$ 4,536,000	$ 12,960,000
Monitoring (65%Fed-35%NFS)	$ 666,900	$ 359,100	$ 1,026,000
Total Construction	**$ 84,900,400**	**$ 45,715,600**	**$ 130,616,000**
TOTAL COST	**$ 91,650,400**	**$ 52,465,600**	**$ 144,116,000**
Cash Contribution	*$ 91,650,400*	*$ 18,405,600*	

The wetlands being lost in the Barataria-Terrebonne estuary complex are of vast ecological importance. It has been estimated that nearly one fifth of the Nation's estuarine-dependent fisheries rely on the diverse habitats of Barataria-Terrebonne. Annual commercial fisheries landings have been estimated at more than $220 million, including oysters, shrimp, crabs, and various finfish. The wetlands and other habitats of the Barataria-Terrebonne estuary complex are also important for a wide range of resident and migratory birds. It is estimated that 353 species of birds are known to have occurred in Barataria-Terrebonne, of which 185 species are annual returning migrants. In total, approximately 735 species of birds, finfish, shellfish, reptiles, amphibians, and mammals spend all or part of their life cycle in the estuary.

By increasing the connection of the river to the bayou, the Bayou Lafourche project would nourish marshes, contribute to soil building through mineral sediment accretion and organic matter production, and combat saltwater intrusion during droughts or prolonged southerly winds. The associated increased vegetative health and vertical accumulation of the marsh surface would counterbalance subsidence and reduce future wetland loss in the area.

Although the WVA many attributes of estuaries that fish and wildlife rely upon, there would be unquantifiable benefits over the 49,000 acres of wetlands and 36,000 acres of estuarine waters, especially with a project such as this that is synergistic with other projects. It is possible that the acres preserved are underestimated. There would be benefits to threatened species such as the bald eagle and higher quality Essential Fish Habitat would be preserved. Waterfowl habitat would be improved.

Having undergone years of interagency and public review, the Bayou Lafourche project is well suited for conditional authorization within the LCA Plan. Since being selected by the CWPPRA Task Force in 1996, the Bayou Lafourche project has undergone considerable environmental and engineering review, including hydraulic modeling and environmental benefits assessment. Most recently, engineering and design and the National Environmental Policy Act process have been initiated as part of the ongoing CWPPRA process. The existing information provides greater certainty with respect to costs and environmental outcomes, and will help expedite completion of both the feasibility study and EIS.

2.8.3.2.5 *Medium diversion with dedicated dredging at Myrtle Grove*

Approximately 1,000 years ago, the Plaquemines Delta began to deposit sediment in the Myrtle Grove study area. Shallow water areas were filled with interdistributary and marsh deposits. The Mississippi River has been in its present location for the past 1,000 years, and the study area continued to receive fresh water and sediment from the Mississippi River and its distributaries.

With the development of the Mississippi River levee system over the last century, once frequent introductions of sediment and nutrients were disrupted. These introductions helped the area accrete sediment and detritus, and the marshes kept pace with subsidence. Another major factor was the dredging of oil and gas and navigation canals that allowed salt water to encroach far inland, resulting in a shift from intermediate marshes to slower-growing brackish marshes. The high subsidence rate combined with these factors resulted in a rapid degradation of the marshes in the area.

The project area is currently a sediment-starved system with little freshwater input. These factors have magnified the high subsidence in the area, resulting in massive land loss. To counteract this loss, the project area needs inputs of both sediment and water. The Davis Pond diversion provides freshwater input into the basin to the north, but local marshes are too far removed from the diversion structure to benefit directly from the introduction of nutrients, and the salinity regime would be more controllable with a freshwater input closer to the area of need.

The Medium Diversion with Dedicated Dredging at Myrtle Grove critical near-term feature addresses both the need to preserve long-term restoration opportunities and to bring significant reversal of the wetland loss trend. In preserving long-range restoration opportunities, implementation of this feature also supports several possible outcomes of proposed large-scale studies. The immediate restoration impact of the implementation of the Myrtle Grove feature is significant in addressing predicted future wetland loss in an ecologically critical zone of habitat transition in one of the most productive estuaries in the Nation. In addition, commercial and private development at the perimeter of this basin, located to take advantage of its productivity and to support local, regional, and National economic interests, would receive benefits from the restoration of these wetlands. These benefits would include continued sustainable biologic productivity in the estuary as well as the indirect benefit of reduction of storm-driven tidal stages.

The key components of the proposed feature include:

- A gated diversion structure with a capacity of approximately 5,000 cfs
- Inflow and outflow channels totaling approximately 16,000 feet
- Associated channel guide levees and infrastructure relocation
- Creating at least 6,500 acres of new marsh through dedicated dredging

This project is predicted to create/preserve 6,563 acres over the next 50 years. The estimated cost for designing and constructing the Myrtle Grove Diversion and Dedicated Dredging feature is $293.962 million (including monitoring). Details of this cost estimate are provided in **tables 2-28** and **2-29**:

Table 2-28. Summary of Costs for the Medium Diversion with Dedicated Dredging at Myrtle Grove (June 2004 Price Level)

Lands and Damages	$	78,990,000
Elements:		
Relocations	$	3,780,000
Ecosystem Restoration	$	96,970,000
Channels and Canals	$	24,150,000
Diversion Structures	$	21,800,000
First Cost	$	225,690,000
Feasibility-Level Decision Document	$	22,005,000
Preconstruction Engineering and Design (PED)	$	14,670,000
Engineering and Design (E&D)	$	8,215,000
Supervision and Administration (S&A)	$	21,125,000
Monitoring	$	2,257,000
Total Cost	**$**	**293,962,000**

Table 2-29. Medium Diversion with Dedicated Dredging at Myrtle Grove FEDERAL AND NON-FEDERAL COST BREAKDOWN (June 2004 Price Level)

Item	Federal	Non-Federal	Total
Decision Document (50%Fed-50%NFS)	$ 11,002,500	$ 11,002,500	$ 22,005,000
PED (65%Fed-35%NFS)	$ 9,535,500	$ 5,134,500	$ 14,670,000
LERR&D (100% NFS)	$ -	$ 82,770,000	$ 82,770,000
Ecosystem Restoration (65%Fed-35%NFS)	$ 142,920,000	$ -	$ 142,920,000
Engineering and Design (E&D) (65%Fed-35%NFS)	$ 6,339,750	$ 1,875,250	$ 8,215,000
Supervision and Administration (S&A) (65%Fed-35%NFS)	$ 16,509,750	$ 4,615,250	$ 21,125,000
Monitoring (65%Fed-35%NFS)	$ 1,467,050	$ 789,950	$ 2,257,000
Total Construction	**$ 176,772,050**	**$ 95,184,950**	**$ 271,957,000**
TOTAL COST	**$ 187,774,550**	**$ 106,187,450**	**$ 293,962,000**
Cash Contribution	*$ 187,774,550*	*$ 12,414,950*	

Currently authorized Federal environmental projects (in this specific case, the Davis Pond Freshwater Diversion project) have been designed to sustain and stabilize the present basin wide salinity regime. This outcome falls short of the broader restoration objectives, but existing projects can and will be incorporated or modified in the implementation of this and other future restoration efforts. In this manner, the proposed restoration feature would also support adaptive management and learning goals and provide a platform for additional learning through add-on demonstration projects.

The proposed restoration feature considers a diversion ranging from 2,500 to 15,000 cfs coupled with dedicated dredging for the creation of up to 19,700 acres of new wetlands. This combination would allow for rapid creation of wetland acreage and long-term sustainability. The diversion will allow the reintroduction of freshwater, sediment, and nutrients into the critically effected area of the basin in a manner similar to the rise and fall of the river's hydrologic cycle. The rate of reintroduction would be optimized according to the overall planning objectives of the LCA restoration effort to maintain hydro-geomorphic diversity and connectivity, as well as habitat diversity. The dedicated dredging component of the Myrtle Grove feature would allow immediate recovery of former wetland areas already converted to open water. The combination is also expected to maximize the amount of acreage created per yard of sediment placed by capitalizing on incremental accretion of diverted sediment.

A diversion from the Mississippi River would provide both resources, and would provide a relatively cost-effective way to recreate land in the project area. Nevertheless, the land accretion process is slow, and an introduction of material through dedicated dredging would provide for a marsh platform immediately. To balance the need for wetland acreage in the near-term with the ability to sustain the marshes over the long-term, various combinations of marsh creation through dedicated dredging and freshwater introductions through a river diversion would be examined.

The proposed restoration feature has the potential to prevent significant future land loss where currently predicted to occur in the central portion of the Barataria Basin. Ecologic modeling indicates that, in the next 50 years, all saline and brackish marsh and approximately 40 percent of the intermediate marsh in the Barataria Basin will be lost. This can be attributed to lack of sediment input, and continued soil subsidence. In addition to directly resulting in wetland loss, these factors are compounded by the low success of saline vegetation reestablishing on the highly organic soils established in fresh marshes. These combined factors, along with the projected hydraulic and ecologic trends in, and current make up of the area in the vicinity of Myrtle Grove, indicates that it is at particularly high risk.

The restoration of wetlands in this area would also protect and support socio-economic interests located in the central and upper portions of the Barataria Basin to capitalize on the fisheries productivity of the estuary. The communities of Lafitte and Barataria represent the southernmost development in the interior of the Barataria Basin and are located outside of any existing hurricane protection works. Loss of the existing wetland structure would have an immediate impact on the sustainability of these communities. In addition, industries located along the Mississippi River in the vicinity of Myrtle Grove would also become threatened with the loss of interior wetlands in this area. Currently, there is no Federal hurricane protection levee parallel to the river in this area. The absence of this protection is due, in part, to the historic presence of the wetlands.

The Medium Diversion with Dedicated Dredging at Myrtle Grove restoration feature addresses critical ecological needs in a sensitive area of the most highly productive estuarine systems in the Nation. The components of the feature create a synergy that would result in highly productive and sustainable outputs. The design and operation of the feature would maintain the opportunity for and support the development of large-scale, long-range comprehensive coastal restoration. The feature would also support opportunity for resolution of scientific and technical uncertainties through incorporation of demonstration projects and/or adaptive management.

2.8.3.2 Future Congressional Authorization for implementation of critical restoration features

The near term critical restoration features within the LCA Plan that are not conditionally authorized would be submitted to Congress for consideration of authorization in future WRDAs. Based on an analysis of the current LCA Plan schedule, components would have feasibility-level decision documents or Feasibility Reports completed and ready to submit to Congress through FY 2013, with construction starting no later than FY 2014.

2.8.4 Large-Scale and Long-Term Concepts Requiring Detailed Study

During plan formulation, the PDT identified several candidate large-scale and long-term concepts for potential incorporation into the LCA Plan. These restoration concepts exhibited a greater potential to contribute to achieving restoration objectives in 1) the subprovince within which they would be located, 2) adjacent subprovince(s), and/or 3) substantial portions of Louisiana's coastal ecosystem. Accordingly, the corresponding benefits and costs for these potential plan features should be further analyzed and confirmed to determine how best to incorporate them, if at all, with other plan features. Upon completion of detailed feasibility studies, recommendations for action would be documented in the manner specified for features that would be proposed for Congressional authorization, and would be subject to the standard review and authorization process for USACE water resources projects. Short descriptions of the large-scale, long-term concepts are included below.

2.8.4.1 Acadiana Bays Estuarine Restoration Study

The primary goal of this study is to evaluate the potential for reestablishing historic water quality conditions and viable estuarine fisheries in the Acadiana Bays system while maintaining a growing delta system in Atchafalaya Bay. The Acadiana Bays area of Louisiana consists of those bays in the central part of coastal Louisiana including from east to west, Four League, Atchafalaya, East Cote Blanche, West Cote Blanche, Weeks, and Vermilion Bays (**figure 2-18**).

During the last half of the 20th century, this estuary has experienced a freshening trend and increased turbidity. As a result, submerged aquatic vegetation densities and the viability of estuarine fisheries have declined. Several factors have led to these problems. In 1900, the Atchafalaya Basin received about 5 percent of the total of the Red River and Mississippi Rivers. By the 1950s, the Atchafalaya share had grown to 30 percent and has remained at that distribution with the construction of the Old River Control Structures in the early 1960s. Even though the flow distribution down the Atchafalaya has been stabilized, the basin has experienced significant changes in the twentieth century, resulting in greater efficiency to convey water and sediment to the estuary. Also, at one time, the bay complex reportedly contained the largest concentration of oyster reefs in the United States. The remnant reefs had limited wave action and storm impacts in the Acadiana Bays by providing a physical barrier to exchange; however these were largely destroyed by shell dredging prior to the mid-1980s. Removing this reef complex eliminated natural baffles between the Gulf of Mexico and Atchafalaya Bay, as well as Atchafalaya and West Cote Blanche Bays.

Figure 2-18. The Acadiana Bays, Louisiana.

The State of Louisiana has conducted initial engineering studies for restoration of the Acadiana Bays estuary. The large-scale study would expand on this effort by improving existing hydrodynamic models, using existing and new data to evaluate the salinity and turbidity levels in the Acadiana Bays system and ultimately determining the best course of action for restoration and maintenance of this estuarine system.

Several potential alternatives that have been proposed including construction of a rock jetty or a series of staggered reefs from Pt. Chevreuil to Marsh Island to impede the western flow of fresh water and sediment from Atchafalaya Bay, and shoreline stabilization and/or gap closures on the GIWW and the eastern shoreline of Freshwater Bayou Canal to minimize freshwater flow into the Acadiana Bays system.

The Acadiana Bays Estuarine Restoration Study would ultimately aid in defining the restoration plans of this ecologically important region of coastal Louisiana. This study has an anticipated start date of FY06 and an anticipated finish date of FY09, with an approximate cost of $7,110,000.

2.8.4.2 Upper Atchafalaya Basin Study

The study purpose is to conduct a system-wide comprehensive analysis of the problems and opportunities related to flood control, navigation, and ecosystem sustainability for the lower Red River, Old River, Mississippi River, and Atchafalaya River Basins.

This study relates primarily to the Mississippi River and Tributaries Project and, as such, would be funded under that project. It is discussed in this report because it would link closely with the Mississippi River Hydrodynamic Study (via the modeling to be developed) and because several proposed LCA features would either impact the operation of the ORCS and/or effect changes to the Atchafalaya Basin, the Mississippi River, and the coastal zone. As such, any potential LCA alternatives would have to assess the potential impacts to the existing river systems.

The primary objectives of the study are to:

1. Determine whether improvements are necessary to sustain the MR&T project's ability to pass project flow, maintain an efficient and safe navigation system, and maintain channel and bank stability.
2. Investigate the degradation of the Atchafalaya Basin and its ecosystem and develop solutions to stabilize and restore the system.
3. Investigate the sediment distribution needs and capabilities of the ORCS and determine the optimum distribution that is required to ensure adequate flood control, safe navigation, and ecosystem sustainability.

The secondary objectives of the study are to:

1. Investigate means to improve water quality and circulation in degraded areas of the Atchafalaya Basin that are not covered by the Water Management Units.
2. Investigate the ability of the system to transport sediment and freshwater to the Louisiana coastal area for delta building and marsh restoration purposes.
3. Investigate the potential of the system to further contribute to coastal ecosystem restoration.

This large-scale study would examine modifications to the ORCS operation to alter water circulation in the Atchafalaya Basin back swamps and associated lakes and bayous. Altering water circulation may achieve greater transport of sediment to coastal wetlands and reduced nutrient delivery to the Gulf of Mexico. Other potential benefits include enhanced water quality and aquatic ecosystem health in the upper Atchafalaya Basin Floodway. Adjustments to the operation of the ORCS may include daily and seasonal deviations from the 70/30-flow distribution while maintaining the flow distribution on an annual basis. Channel modifications within the upper basin would also be examined.

Increased sediment availability to coastal wetlands may act synergistically with other efforts to maximize the beneficial influence of these vital river resources through other elements of the near term LCA Plan. This includes the enhancement of Atchafalaya River/GIWW freshwater inflows into the central and eastern Terrebonne Basin, the operation of the Houma Navigation Canal Lock, and other water control features within the proposed Morganza to the Gulf Hurricane Protection Project for restoration purposes. The Atchafalaya River Diversion Study is expected to begin in FY04 and end in FY07.

2.8.4.3 Chenier Plain Freshwater and Sediment Management and Allocation Reassessment Study

The purpose of this study is to further develop a comprehensive management plan to restore the Chenier Plain's large-scale system hydrology and maximize the influence of the available sediment and fresh water. More efficient management of the existing limited water and sediment resources would stabilize and restore the wetlands of the region.

This study area is comprised of the Louisiana Chenier Plain, which extends from the western bank of Freshwater Bayou westward to the Louisiana-Texas border in Sabine Lake, and from the marsh areas just north of the Gulf Intracoastal Waterway (GIWW) south to the Gulf of Mexico in Vermilion, Cameron, and Calcasieu parishes. Although this system is linked to the Mississippi River Delta, the processes which governed its creation and subsequent degradation are different from those that affect the Deltaic Plain. The Chenier Plain wetland ecosystem developed primarily as a result of the interplay of three coastal plain rivers (Sabine, Calcasieu, and Mermentau Rivers), the intermittent mudstream from the Mississippi River outlets, and the Gulf of Mexico. During periods of active delta building in the western Mississippi Deltaic Plain, gulf currents transport fine-grained sediment west in a mudstream towards the Chenier Plain and form expansive mudflats. As Mississippi River Delta building switched to the east, this influence is removed and gulf processes rework the mudflats into beach ridges (cheniers). Subsequent westward shifts of the Mississippi River strand these cheniers inland, giving the Chenier Plain its defining characteristic.

Public works projects and other man-made and natural factors have altered the hydrology of the Louisiana Chenier Plain. In some areas, the estuarine character has been completely lost. In others, enhanced marine and tidal influences to sensitive areas have contributed to marsh degradation. Previous study efforts have indicated the technology currently applied to address the problems of the Louisiana Chenier Plain may be ineffective and insufficient to restore this region's landscape. A greater understanding of the availability of freshwater and sediment is necessary to plan appropriate ecosystem actions in the area.

Building on existing and ongoing modeling efforts, this study would help facilitate the development of a comprehensive restoration plan for the Chenier Plain ecosystem. Potential features to be analyzed may also include modification of existing authorized navigation and flood control projects, dedicated or beneficial use of dredged material, shoreline protection, modifications of land-use practices, and restoration of tidal influence to appropriate areas. The study is scheduled to begin in FY04 and conclude in FY07 at an estimated cost of $12 million.

2.8.4.4 Mississippi River Delta Management Study

The purpose of this study is to identify and evaluate features that would greatly increase the deposition of Mississippi River sediment in shallow coastal areas and restore deltaic growth in the Mississippi River Delta Plain. The study area is the Mississippi River Delta below Pointe a la Hache.

Every year, the Mississippi River transports millions of cubic yards of sediment to the delta at the mouth of the river. The District dredges approximately 31 mcy (2.4 million cubic meters) of sediment (sand) in the lower Mississippi. The river also transports a suspended sediment load (mostly silts) to the mouth of about 70 mcy (5.4 million cubic meters). Most of this material, as well as some of the sand load, is transported to deep waters of the Gulf of Mexico. However, little of this material is captured by the surrounding wetlands around the Mississippi River Delta. In addition, excess nutrients are diverted offshore instead of filtering through wetlands for assimilation, which leads to the annual development of a significant hypoxic zone in the northern Gulf of Mexico. The lack of sediment and nutrient input into the surrounding marshes has reduced regional soil building rates to a point where they are insufficient to offset effects of relative sea level change (RSLC), and massive land loss has resulted.

The District completed a Mississippi River Delta Reconnaissance Study in 1990 that indicated significant potential land building could be achieved by implementing diversion and channel projects, but environmental and economic analyses were insufficient to fully evaluate the NER/NED benefits and impacts. Recent investigations with a small-scale physical model have also indicated qualitatively that river diversions as well as alternative arrangements of navigation channels may contribute significantly to the restoration program. Environmental benefits would potentially include increased land building and maintenance and reduced hypoxia in the gulf.

This study would analyze two types of projects—large diversions (greater than 50,000 cfs [1,400 cms]) from the Mississippi River and alternative navigation channel alignments. The large- scale river diversions could potentially maximize the river's sediment and freshwater resources available for ecosystem maintenance. Diversion sites, capacities, and outfall management measures would also be assessed to help optimize diversion plans. Such massive diversions, however, may cause adverse impacts to the existing navigation channel; so alternative scenarios must be investigated to accommodate navigation needs. Alternate navigation scenarios include new channels to the east or west of the current river while providing navigation either in the new channel or by maintaining the existing navigation channel as a slack-water channel by the construction and operation of a lock system. In addition, the study would evaluate potential impacts of natural and man-made factors on the environment and economy. The study will run from FY06 through FY10 at an estimated cost of $15,350,000.

2.8.4.5 Mississippi River Hydrodynamic Study

Development of a Mississippi River Hydrodynamic Study, which would represent the existing Mississippi and Atchafalaya river systems below ORCS is necessary to properly assess the operation and parameters of the MR& river system with respect to water and sediment transport, flood control and navigation. The proposed study area encompasses the Mississippi and Atchafalaya Rivers from the ORCS to the Gulf of Mexico.

Although significant data has been collected on the amount of sediment, nutrients, and freshwater available in the river system, this information has not been assembled in a comprehensive modeling/study effort that would allow reliable estimates of the quantities of the total resources (water and sediment) that can be allocated for restoration purposes without compromising the river's existing navigation and flood control functions.

This study effort would include data collection, data synthesis, extension of existing modeling, and possibly new models. The comprehensive study would assist in determining the need, location, size, and seasonal variations for planned diversions and future restoration projects. Once a comprehensive model has been developed, calibrated, and verified for existing conditions, it would then be used to simulate a new base condition for the coastal area, one that represents/simulates the collective impacts of the near-term features and any other existing or planned projects that affect the river systems. As the average flow in the Mississippi/ Atchafalaya system is about 640,000 cfs (18,000 cms), the relatively small diversions in the near-term plan are unlikely to have a significant cumulative impact to the river system, but would become the base condition as these projects are implemented. The base condition model would then be used to evaluate the impacts of potential large-scale restoration features on the river system. In addition, the model would be used to evaluate adaptive management and potential adjustments to restoration features. This study is scheduled to begin in FY04 and end in FY07 at an estimated cost of $10,250,000.

2.8.4.6 Third Delta Study

The purpose of the Third Delta Study is to examine large-scale alternatives for the restoration of the lower areas of Terrebonne, Lafourche, and Jefferson parishes in the region of the Barataria-Terrebonne National Estuary. As proposed by Gagliano and van Beek (1999), this restoration concept involves constructing a conveyance channel parallel to Bayou Lafourche that would carry Mississippi River water and sediment to the western Barataria and eastern Terrebonne Basins in order to create two new deltas in this estuarine complex.

The Barataria-Terrebonne estuarine complex is bounded by the Mississippi and Atchafalaya Rivers. Bayou Lafourche separates this complex into two basins, Barataria Basin to the east, and Terrebonne Basin to the west. Bayou Lafourche was the main route of the Mississippi River until about 800 to 1,000 years ago. When the river changed course, Bayou Lafourche and the Lafourche delta gradually entered the final degradation phase of deltas. As such, flow from the Mississippi River down Bayou Lafourche gradually decreased until, by the mid-1800s, the bayou was a minor distributary. Prior to 1904, Bayou Lafourche maintained a hydrologic connection to the Mississippi River. Flows down the bayou were relatively small except during large floods on the Mississippi River, but helped to maintain some areas of the estuary. When the bayou was closed off from the Mississippi River in 1904 to provide flood protection along the bayou, water quality and quantity in the bayou decreased and no longer helped sustain the estuary. In the 1950s a pumping station was constructed at Donaldsonville, to divert up to 340 cfs (10 cms) from the Mississippi River into Bayou Lafourche to help improve water quality and provide water supply along the bayou (although channel conditions limited diversions to about 200 cfs [6 cms]). Conditions in the estuary, however, continued to deteriorate.

Today this area experiences the greatest rates of land loss along the entire Louisiana coast due to the numerous factors associated with coastal loss, including the disconnection of the estuarine system from the Mississippi River, the natural subsidence of the marsh, sea level change, oil & gas exploration, channelization, salinity intrusion, etc. This endangered ecosystem serves as valuable habitat for numerous species of birds, finfish, shellfish, reptiles, amphibians, and mammals that spend all or part of their life cycle in the Barataria-Terrebonne estuary, including several species that are categorized as either threatened or endangered. The vast acreage of marsh that is being eroded also serves to protect critical oil and gas infrastructure as well as the Louisiana Highway 1 corridor connecting Port Fourchon and Grand Isle to the rest of the state and Nation.

Restoration of the lower areas of Barataria-Terrebonne, and especially the eastern Terrebonne marshes on the western side of Bayou Lafourche, has been confounded by the long distances sediment must travel from the Mississippi River. The Third Delta concept proposed by Gagliano and van Beek (1999) involves creating a new delta between the Atchafalaya River and Mississippi River Birdfoot Deltas. The proposed two new deltas would be formed by sediment carried through a constructed conveyance channel. To reduce channel construction cost and increase availability of sediment in the created delta, a pilot channel would be constructed, and natural riverine processes would erode the conveyance channel to its final design width and discharge. The conveyance channel, as proposed, would follow the eastern slope of the natural Bayou Lafourche levee system, and split into two channels near Raceland. The eastern channel would terminate in Little Lake in Barataria Basin, and the western channel would cross Bayou Lafourche and carry sediment to Terrebonne Basin, ending near the Pointe au Chein Wildlife Management Area, north of Lake Felicity and Lake Raccourci (**figure 2-19**).

The State of Louisiana has conducted initial engineering studies of the Third Delta concept and concluded that the concept as proposed by Gagliano and van Beek (1999) could be engineeringly feasible, although serious concerns remain regarding the time scale and spatial extent of land building, the destruction of valuable swamps and marshes within the path of the conveyance channel, and the drastic alterations of the estuarine character of the receiving areas. In developing the feasibility study, the LCA Program would proceed with three additional phases: identifying alternatives to the proposed concept that would attain project goals, analyzing the significant environmental and economic effects of each alternative, and determining the economic feasibility of implementing the best project alternative. Potential alternatives include alternate diversion routes, the use of dedicated dredging, pipeline conveyance of sediment from the Mississippi River, and diverting water from the Atchafalaya River into Terrebonne Basin. As this study progresses, assessment tools developed under the Mississippi River Hydrodynamic Study, previously discussed, would be used to evaluate the water and sediment transport capabilities of the alternative plans evaluated. Restoration of the Western Barataria-Eastern Terrebonne estuarine complex is challenging because of its remote location relative to the Mississippi and Atchafalaya Rivers. Yet, successfully restoring this region is crucial to the long-term sustainability not only of the coastal wetlands, but also to the sustainability of one of the world's most productive fisheries, and to protection of communities and infrastructure that is vital not only to the State of Louisiana, but also the Nation.

The study is currently underway through efforts funded by the State of Louisiana and would conclude in FY10, at an estimated cost of $15,290,000.

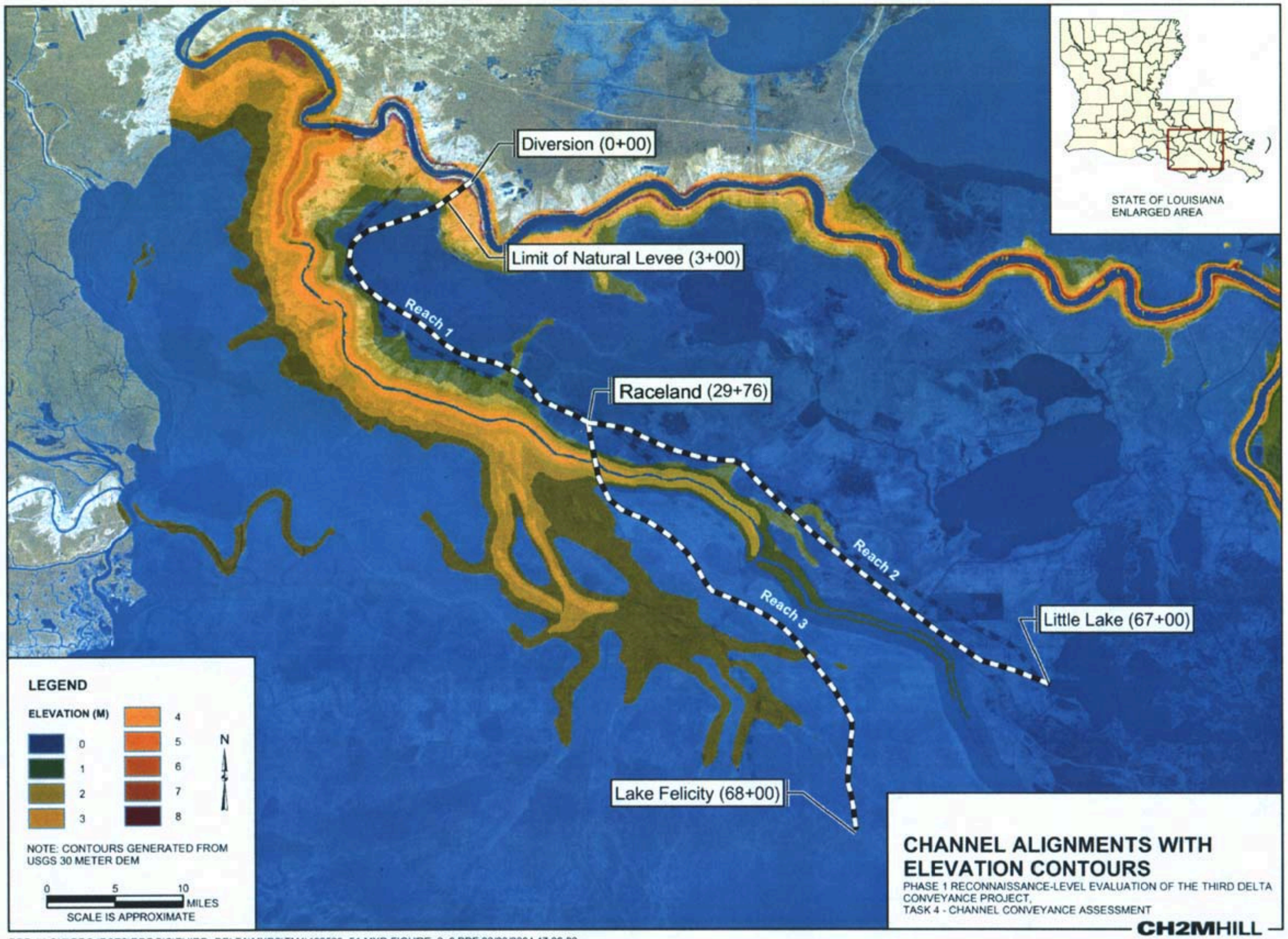


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Figure 2-19. Location of proposed conveyance channel for the Third Delta Study (LDNR, 2004).

2.8.5 Science and Technology (S&T) Program

Section 3.1 PLANNING CONSTRAINTS detailed the key scientific uncertainties and engineering technology challenges in LCA implementation. Appendix A SCIENCE AND TECHNOLOGY PROGRAM details the proposed plan and program to resolve these challenges and facilitate effective implementation. It is proposed that a 10-year Science and Technology S&T (S&T) Program be funded as an authorized item subject to construction cost share percentages (65 percent Federal and 35 percent non-Federal would be applied for construction features and the S&T Program) at a total amount not to exceed $100 million. A major component of the S&T Program would be programmatic authorization for demonstration projects.

The LCA S&T Program would provide a strategy, organizational structure, and process to facilitate integration of science and technology into the decision-making processes of the Program Management and the Program Execution Teams. Implementation of this S&T Program would ensure that the best available science and technology are available for use in the planning, design, construction, and operation of LCA Plan features, as well as other coastal restoration projects and programs, such as CWPPRA. There are five primary elements in the S&T Program (outlined in the S&T Plan) and each element has a different emphasis and requirement. These include: (1) S&T Information Needs, (2) Data Acquisition and Monitoring, (3) Data and Information Management, (4) Modeling and AEAM, and (5) Research. Determining S&T needs requires a continuous process in place that solicits such needs from Program Managers, the PET, and scientists. Data Acquisition and Monitoring require standard operating procedures and rigorous adherence to those standards. Data and Information Management requires standards and procedures to assure data can be shared or compiled from a variety of sources. Modeling and AEAM requires broad interactions among scientists, Program Management, and the PET. Research requires clear hypothesis testing and a substantial degree of scientific independence but close coordination with the PET. A systematic process would be established to provide minimum standards for data quality and data management for information received and used by LCA.

The LCA S&T Program would perform the following:

- Work with LCA Program Management and the LCA PET to review and assess goals, objectives, and key documents of the LCA Program, Identify S&T needs to assist the LCA Plan in meeting those goals and objectives;
- Establish and maintain independent science and technology advisory and review boards;
- Manage and coordinate science projects for (1) data acquisition and monitoring, (2) data management, (3) modeling, and (4) research to meet identified scientific needs of the LCA Plan;
- Coordinate with other research efforts, such as CREST program; the Louisiana Governor’s Applied Coastal Research and Development Program, and other state and Federal R&D entities;

- Incorporate lessons learned and experiences (pros and cons) of other large-scale ecosystem restoration science and engineering programs such as the Everglades, Chesapeake Bay, and Calfed;
- Conduct scientific evaluations, assessments and peer reviews to assure that the science implemented, conducted or produced by the S&T Program meets an acceptable standard of quality, credibility, and integrity;
- Establish performance measures for restoration projects and monitor and evaluate the performance of program elements;
- Improve scientific understanding of coastal restoration issues within the context of AEAM, infuse this improved information into planned or future restoration planning, projects and processes conducted by the PET;
- Prepare scientific documents including a periodic Science and Technology Report and conduct technical workshops and conferences; and
- Provide reports on science projects to support the Government Performance and Results Act (GPRA).

Monies allocated for the S&T Program would be used to:

- Establish and staff the S&T Office;
- Develop, implement and maintain a comprehensive data management structure and process;
- Establish, in concert with the CRMS, key monitoring stations to collect critical baseline data for planned projects and long-term monitoring of ecosystem status and trends;
- Identify key S&T uncertainties and focus efforts (e.g. monitoring and assessment, demonstration projects, research) to resolve them; and
- Develop analytical tools (i.e., hydrodynamic, ecological, and socioeconomic models) to help the Program Execution Team more effectively predict potential feature outcomes

Data collection and monitoring and assessment efforts to fully support the implementation of the LCA Plan and the S&T Program would require extensive collaboration between and funding support from Federal and state agencies, NGOs, and universities. Further details regarding the S&T Program can be found in appendix A: SCIENCE AND TECHNOLOGY PROGRAM.

2.8.6 Programmatic Authorization for Demonstration Projects

The purpose of LCA S&T Program demonstration projects is to resolve critical areas of scientific, technical, or engineering uncertainty while providing meaningful restoration benefits whenever possible. After design, construction, monitoring, and assessment of individual demonstration projects, the LCA Program would leverage the lessons learned to improve the planning, design, and implementation of other Louisiana coastal zone restoration projects.

There are numerous types of uncertainties to be addressed to support and improve LCA restoration efforts. Each uncertainty requires a different resolution strategy, based on the effects of the uncertainty on the program, degree of uncertainty, cost of addressing the uncertainty, and importance of reducing the uncertainty. Different strategies for resolving uncertainties may include, focused research projects, focused monitoring of existing projects or natural conditions, or demonstration projects.

Uncertainties may be related to basic understanding of the data availability, science, modeling, and other analytical tools, socio-economic impacts, implementation, technical methodology, resource constraints, cost, or effectiveness of restoration features. Uncertainties may also be related to development and refinement of forecasting tools. An uncertainty is considered critical if its resolution is vital to advancing the planning and implementation of the LCA Plan in the near-term. A role of the S&T Program is to identify and prioritize critical areas of uncertainty, to formulate the most appropriate means of resolving uncertainties, to ensure focused data collection aimed at resolving these areas of uncertainty, and to make recommendations to LCA Program Management regarding program and project refinements in light of the reduced uncertainty.

Critical areas of uncertainty identified by the PET, academics, or agency personnel would be proposed to the S&T Office Director. Proposed areas of uncertainty should be identified in relation to anticipated program activities. However, the S&T Office would not be constrained to targeting only these needs, and would be open to facilitating the pursuit of new technology, experimentation, and innovative ideas when suitable for the advancement of the LCA Program.

Areas of uncertainty would be prioritized based on the relative importance of resolution of the uncertainty to advancing the LCA Program. The S&T Office Director would be responsible for determining the significance of the uncertainties relative to the advancement of the LCA Program in coordination with Program Management and the PET.

Demonstration projects represent one of several strategies that the S&T Office would employ to reduce uncertainties. Demonstration projects may be necessary to address uncertainties not yet known and discovered in the course of individual project implementation or during the course of studies of large-scale and long-term restoration concepts. The Program Manager would review and approve requests from the S&T Director to prepare decision documents of potential demonstration projects. In addition to standard decision document information, the demonstration project decision documents would clearly identify major scientific or technological uncertainties to be resolved and a monitoring and assessment plan to ensure that the demonstration project would provide results that contribute to overall LCA Program effectiveness. Once the completed decision document is approved by the Secretary of the Army, construction could begin.

It is proposed that demonstration projects developed by the S&T Program be funded as a construction item at an amount not to exceed $100 million over 10 years, including a maximum cost of $25 million per project. The PDT developed five initial candidate demonstration projects, but these may be modified or replaced by demonstration projects of higher priority as determined by the S&T Director. In order to support continued development of the LCA Plan through AEAM, it is possible that additional and/or different demonstration projects would be needed.

The S&T Office would be responsible for defining and developing all demonstration projects to answer key ecological or technological uncertainties. A short description of some potential demonstration projects is provided below. The potential projects illustrate the general scope and purpose of the demonstration project's concept, but are not intended to represent the only demonstration projects that would be developed once the S&T Office is established.

2.8.6.1 Demo 1 – Marsh restoration and/or creation using non-native sediment

Uncertainty Addressed: This demonstration project would address the uncertainty involved in selecting sources of material for marsh creation, restoration of maritime forests, and restoration of cheniers. There is uncertainty regarding the efficacy of using saline mineral soils to support these habitats. Uncertainties regarding the time required for soil to leach out salts and increase organic matter content in order to make the soils suitable for the establishment of freshwater and terrestrial vegetation would need to be resolved prior to using this technique on a large scale. Other uncertainties include the cost of restoring cheniers and the potential benefits, such as habitat functionality.

Background: Coastal cheniers are critical habitats for many wildlife populations, especially migratory birds; however, these habitats are disappearing rapidly and are designated as critically imperiled by the Louisiana Natural Heritage Program. These chenier habitats provide upland habitat in very close proximity to marshes, which is instrumental in creating diverse upland/wetland assemblages. In addition to providing critical habitat, natural ridges, such as cheniers and natural distributary ridges, provide additional levels of flood protection. In spite of these potential benefits, coastal restoration programs in Louisiana have relatively little experience with chenier restoration.

Because marsh creation and chenier and maritime forest restoration are hampered by the availability of sediment that contains soil characteristics similar to the native soils (most available sediment is located in salt water offshore), it is important to determine the best methods of amending dredged sediment to create soils capable of sustaining this specialized habitat.

Description: This demonstration project could be located in the southwestern Barataria Basin, just north of Port Fourchon, in the "Chenier Unit" of the partially completed Barataria Basin Marsh Creation Study although the specific location of the project would not be selected until careful examination by the S&T Office in consultation with the Program Execution Team. This demonstration project would use different methods of soil modification and planting regimes to determine the quickest and most cost-effective, reliable means of attaining viable soils. A wide variety of variables selected by the S&T Office would be monitored to determine plant productivity, landform stability, and to evaluate impacts related to the acquisition of borrow material and its effect on the local ecosystem.

Anticipated Outputs: This demonstration project would provide insight into appropriate sources of available substrates, cost effective transport mechanisms, and time requirements for vegetation establishment on coastal cheniers. Documentation of impacts related to the acquisition of borrow materials and its effect on the affected area ecosystems would also be provided. This would enable more effective restoration of these habitat types in other areas of the coast.

2.8.6.2 Demo 2 – Marsh restoration using long-distance conveyance of sediment

Uncertainty Addressed: This demonstration project would address the uncertainty involved in marsh restoration through long distance conveyance of sediment via pipeline. Two major components of the demo will be examined: 1) most cost-effective mechanisms for long distance transport, and 2) most effective disposal of transported material to enhance land bridge and marsh construction. Concerns about the cost effectiveness of using conventional dredging techniques to transport large quantities of sediment long distances from sediment sources must be addressed. Conventional dredging equipment typically requires large pipelines for transport of sediment. However, there are uncertainties about how the material can be effectively transported efficiently over long distances and distributed. Variability in the sections of the restored marsh would facilitate monitoring to determine optimal final grade vs. design grade, dewatering periods, and potential water quality effects of transported materials. Tests may also be conducted to assess a two-tiered approach whereby large pipeline systems are used to convey high volumes of material but smaller dredges could be used to then disperse the material into final locations. Different mechanisms to distribute transported sediment within the marsh environment to minimize marsh damage and establish appropriate elevations for sustainable land bridge formation and marsh development would also be examined.

Background: Although modeling results indicate that very large diversions (e.g., 100,000 cfs [2,800 cms]) would build tremendous amounts of land; these results also indicate that such diversions would greatly alter the receiving basin's ecosystem. Furthermore, certain areas of the coastal zone that have experienced the greatest land loss may ultimately prove to be too far removed from the Mississippi or Atchafalaya Rivers for diversions to be a viable restoration technique. Long-distance sediment delivery via pipeline for marsh restoration is a promising alternative to very large diversions.

Dredged sediment is currently used for marsh creation; however, the scale is relatively small and the marsh creation sites are relatively close to the source of the material. Marsh nourishment is the concept of applying sediment to degrading marsh surfaces either by flowing low sediment concentration slurries over the surface or by direct spray disposal. These techniques have been shown to be effective on very small scales, but application to large areas is unproven and presents several challenges. These challenges include the logistics of moving material over and onto existing deteriorating marsh while minimizing damage, the need and methods to ensure vegetation colonization, and the cost-effectiveness of this restoration technique. Because marsh creation and nourishment have been shown to be successful on small, localized scales, the application of this technique on a larger scale makes it an excellent candidate for a demonstration project.

Description: This demonstration project would be located in the vicinity of a degrading land bridge. The specific location would be identified after the S&T Office is established. Techniques to be demonstrated may include spray disposal of dredged sediment to create marsh platforms in open water areas and application of thin sediment slurries over existing degrading marsh. Sources of material may be from offshore areas or from routine navigation channel maintenance dredging.

Anticipated Outputs: Results from this demonstration project would be used to determine the viability of transporting sediment slurries over long distances via pipeline for marsh restoration. Determination of cost-effectiveness would relate to the future use of these techniques. This project is further justified as a demonstration project because results can inform the appropriate design and cost estimates when these techniques are included as alternatives in large feasibility studies. Lessons learned from this demo project would be applicable to other dredging activities throughout the nation. Additionally, lessons learned from this demonstration project could be applied to improve the performance of beneficial use programs associated with the LCA Study and other efforts throughout the nation.

2.8.6.3 Demo 3 – Canal restoration using different methods

Uncertainty Addressed: This demonstration project would address uncertainties involved in restoration of canals. Canals, cut throughout the coastal marshes to support navigation, and oil and gas exploration needs, have resulted in fragmentation and accelerated erosion of many of the marshes. Considerable uncertainty exists and continues to be debated regarding the most effective approach to restoring existing canals. There are also uncertainties regarding the viability of restoration efforts and the timing of restoration.

Background: Many scientific papers suggest that these canals are one of the primary contributors to the land loss problem in coastal Louisiana. In addition to the direct removal of wetlands caused by their construction including dredged material banks, these canals have caused secondary indirect impacts by altering the natural hydrology of marshes and by accelerating erosion rates along the canal banks. The dredged material banks associated with these canals prevent the introduction of sediment and nutrients and cause artificially prolonged flooding. These effects combine to eliminate soil-building processes necessary to counteract subsidence. Additionally, canals provide avenues for higher salinity water to move into previously freshwater marshes, which ultimately leads to land loss. This demonstration project would address the many uncertainties related to canal restoration. The optimum method for closing these canals remains uncertain, but the intended outcome is known. In order to be sustainable, the linkage between wetlands and new sediment and nutrient sources must be reestablished. Thus, it must be demonstrated that the action taken is capable of attaining the desired ecological response by minimizing further erosion along the canal banks and by reestablishing historic hydrologic conditions.

Description: This demonstration project would be constructed in locations in both Barataria and Terrebonne basins, as these areas have some of the highest concentrations of canals. Different approaches to restoration should be examined and monitored including: 1) backfill with small hydraulic or mechanical dredge; 2) placing gaps in the excavated material disposal banks to restore natural hydrology; and 3) constructing plugs at canal entrances as stand alone features to reduce erosion within the canal. If backfill is used, impacts related to the acquisition of borrow material and its effect on the local ecosystem must also be addressed. The S&T Program may recommend additional restoration approaches to carry out this demonstration project or recommend further demonstration projects that build on or expand upon this demonstration project.

Anticipated Outputs: This demonstration project has implications for restoration throughout the entire coast of Louisiana. Once the most beneficial techniques have been identified and costs have been determined, these actions could be implemented as part of the restoration strategies for every subprovince. Any procedures for successful restoration of unused canals resulting from this demonstration project may be shared with regulatory agencies and departments for future permit actions.

2.8.6.4 Demo 4 – Shoreline erosion prevention using different methods

Uncertainty Addressed: This demonstration project would address uncertainties involved in restoration of eroding shorelines throughout the coastal area. Erosion along open bays and channels has lead to wetland losses across the coast. Different approaches to impede future erosion would be examined and monitored for long-term effectiveness, sustainability, and costs. Project monitoring would include comparative evaluations of settlement occurring within the various erosion protection/foreshore protection features.

Description: This demonstration project would be implemented through construction and monitoring of a variety of erosion protection/foreshore protection features in a variety of foundation conditions. This demonstration project would be constructed along several different reaches of shoreline subject to different wave energy regimes.

Anticipated Outputs: Results from this demonstration project would be used to determine the most efficient means of erosion protection/foreshore protection for different foundation conditions and wave energies. The findings from this demonstration project would be applicable to restoration efforts associated with shoreline erosion control. Once the most beneficial techniques have been identified and costs have been determined, these actions could be implemented as part of restoration strategies for the coastal areas

2.8.6.5 Demo 5 – Barrier island restoration using offshore and riverine sources of sediment

Uncertainty Addressed: This demonstration project would address uncertainties involved in restoration of barrier islands with offshore or riverine sources of sand. Focused research and restoration projects already completed in the LCA have contributed to an understanding about the most effective and sustainable island geometry design. However, several issues remain regarding the potential sources of the large quantities of sediment that would be required to re-establish or restore coastal barrier islands. Two sand sources already identified are Ship Shoal and the Lower Mississippi River. Uncertainties related to Ship Shoal are the quantity of available material and the cost-effectiveness of transporting this source relative to other sources. The sources of sands must be quantified and different transport mechanisms tested to determine a cost-effective approach to establishment. Demonstration project test sections would also vary in the types of sediment (percentage of sand/silt/clay) used for barrier islands and back barrier marsh creation. Monitoring would focus on vegetation growth and island stability.

Background: Barrier islands are critical land features in the Louisiana coastal area acting as the first line of defense from daily wave energies in the Gulf of Mexico and from less frequent hurricanes. The islands have been proved to reduce wave height and energy resulting in storm surge protection for coastal communities, but more importantly, the barrier islands provide protection from everyday wave activity; thereby promoting an environment that is conducive to marsh formation and sustainability. The islands also provide critical habitat to numerous species of wildlife, including specialized habitat required for rookeries of endangered brown pelicans. As barrier islands disappear, so do the invaluable services they provide.

Sediment resources located in the open Gulf of Mexico in shallow water are potentially major sources of high quality sand for barrier island restoration. Dredge equipment used for barrier island restoration is available primarily during the winter months. However, open gulf conditions in the winter months limit the ability of typical dredge operations in shallow conditions.

Costs and logistics of dredge operations on a busy commercial channel (the Mississippi) and the feasibility of pumping sediment long distances through a pipeline are difficult to estimate reliably. Other issues are associated with obtaining sediment, such as from Mississippi River point bars, including the renewability of the resource and the effects of removal from the point bars on river currents and navigation. This issue would be answered in part through the demonstration project directed at investigating the pipeline delivery of sediment. This demonstration project would more closely investigate methods associated with barrier island configuration, sediment placement, and habitat configurations (e.g. percent dune to marsh).

Description: This demonstration project would be constructed along sections of the Terrebonne and Barataria barrier islands.

Cost-effective techniques that would be feasible in difficult weather conditions need to be developed to capture and transport sediment from offshore sand bodies to a barrier island restoration site.

Construction of a sediment trap, potentially in the vicinity of the Head of Passes, may also be considered. This would potentially provide a renewable source of large-grained sediment, which could then be dredged and pumped through a pipeline delivery system to restoration sites. Initial construction of the sediment trap would also provide significant volumes of sand that could be used for restoration purposes. Second, sediment from point bars in the Mississippi River may be mined and pumped through a pipeline for delivery to restoration sites.

Anticipated Outputs: The expected output is to determine a viable source of large quantities of material and based on its source and composition the best method of use. Once uncertainties are resolved, these potential borrow sources would be incorporated more fully into future designs of restoration projects in both the Barataria and Terrebonne barrier shorelines.

2.8.7 Programmatic Authorization for the Beneficial Use of Dredged Material

The District has the largest annual channel O&M program in the USACE, with an annual average of 70 mcy (54 million cubic meters) of material dredged. Currently, approximately 14.5 mcy (11.1 million cubic meters) of this material is used beneficially in the surrounding environment with funding from either the O&M program itself or the Continuing Authorities Program (CAP) defined by the WRDA 1992 Section 204 for beneficial use of dredged material. Within the O&M program, beneficial use may be funded if the cost increment increase for the beneficial use transport and disposal is a minimal percentage increase above the O&M Base Plan for standard transport and disposal. The CAP Section 204 provides another funding source to "carry out projects for the protection, restoration, and creation of aquatic and ecologically related habitats, including wetlands, in conjunction with dredging for construction, operation, or maintenance by the Secretary [of the Army] of an authorized navigation project." Section 204 projects are completed in conjunction with existing O&M contracts and pay for the incremental cost above the Base Plan for the beneficial use alternative. The Base Plan is defined as "Disposal of dredged material … in the least costly manner consistent with sound engineering practice and meeting all Federal environmental requirements." Combined, the existing O&M program and the CAP Section 204 (with $15 million in annual funding spread throughout USACE) do not provide the resources for the District to take full advantage of the available sediment resources.

The LCA Plan would be enhanced by programmatic authorization for beneficial use of dredged material. This program would allow the District to take greater advantage of existing sediment resources made available by maintenance activities to achieve restoration objectives. Annualized, there is reasonable potential to use an additional 30 mcy (23 million cubic meters) of material beneficially if funding were made available. (A portion of the average annual material total of 70 mcy (54 million cubic meters) is not available for beneficial use because it is resuspended material from upstream maintenance; if taken out of the system upstream, it is not available for downstream beneficial use.) Other limitations within particular areas include threatened and endangered species operating restrictions; cultural resource site operating restrictions; and unfavorable maritime working conditions. The following list is a small subset of the many areas with significant opportunity for additional beneficial use of material in coastal Louisiana:

- The MRGO, LA, project;
- The bay reach of the Barataria Bay Waterway, LA project;
- The MR&T project, Head of Passes and Southwest Pass;
- The Atchafalaya River and Bayous Chene, Boeuf, and Black, LA, project;
- The inland reach of the Calcasieu River and Pass, LA, project; and
- The Houma Navigation Canal.

The LCA Plan recommends $100 million in programmatic authority to allow for the extra cost needed for beneficial use of dredged material. Funds from the Beneficial Use of Dredge Material Program would be used for restoration activities that are above and beyond what would otherwise be funded by the USACE O&M program. Approximately 15 percent would be used for feasibility studies, and the remaining $85 million would be used for placement of dredged material within the acquired disposal sites. Previous Section 204 projects have demonstrated an incremental cost of $1.00 per CY for placement. Additionally, these projects have demonstrated approximately 0.00025 acres per CY (0.0001 ha per CY) created. Based on the requested funds and a ten-year period of implementation, it is expected that the LCA beneficial use of dredged material could attain approximately 21,000 acres (8,500 acres) of newly created wetlands. This beneficial use program represents a vital opportunity to contribute to the attainment of the LCA objectives. Programmatic authority would allow for the application of funds appropriated for LCA for beneficial use of dredged material under guidelines established by the Secretary of the Army, which may be similar to the current guidelines specified for the Section 204 Continuing Authorities Program. Approval of individual beneficial use projects may be delegated by the Secretary of the Army and managed by Division based on the appropriated annual funds. Implementation would proceed with a more detailed analysis of the potential beneficial use disposal sites. Additional funds should not exceed $100 million over the initial 10 years of the LCA program and would greatly contribute to achieving restoration objectives by utilizing existing sediment resources from coastal zone navigation channels.

2.8.8 Programmatic Authorization for Investigations of Modifications of Existing Structures

Coastal Louisiana is a dynamic environment that requires continual adaptation of restoration plans. With this recognition, opportunities for modifying or rehabilitating existing structures and/or their operation management plans to contribute to the LCA ecosystem restoration objectives may be required in the future. Examples of existing structures include: Davis Pond, Bonnet Carré Spillway, MRGO, Bayou Sorrel Lock, and Leland Bowman Lock. Each of these structures may be modified to influence flow, stage, and/or water quality.

Initiation of investigations of modifications of existing structures requires advanced budgeting. Standard budget sequencing may limit responsiveness to recommendations made within the LCA Plan. As a result, the LCA Plan seeks programmatic authorities to initiate investigations of modifications of existing structures utilizing funds within the LCA appropriations, not to exceed $10 million.

2.8.9 Cost Estimates for Components of the LCA Plan

Estimated costs for each of component of the LCA Plan are shown in **table 2-30**. Cost estimates are based on June 2004 price levels.

The fully funded cost estimate of the five near-term critical restoration features are as follows:

- MRGO Environmental Restoration Features $121,736,000
- Small Diversion at Hope Canal $ 80,281,000
- Barataria Basin Barrier Shoreline Restoration $275,471,000
- Small Bayou Lafourche Reintroduction $167,582,000
- Medium Diversion with Dedicated Dredging at Myrtle Grove $340,311,000

The fully funded cost estimate for the LCA Plan is $2,323,653,000.

Table 2-30. LCA Plan Component Cost Estimates (June 2004 Price Levels)

Item		Cost ($)
MRGO environmental restoration features		$ 80,000,000
Small diversion at Hope Canal		$ 10,645,000
Barataria Basin Barrier shoreline restoration		$ 181,000,000
Small Bayou Lafourche reintroduction		$ 75,280,000
Medium diversion with dedicated dredging at Myrtle Grove		$ 142,920,000
	SUBTOTAL	$ 489,845,000
LERRD		$ 178,619,000
First Cost	SUBTOTAL	$ 668,464,000
Feasibility-Level Decision Documents		$ 54,673,000
Preconstruction, Engineering, and Design (PED)		$ 36,252,000
Engineering and Design (E&D)		$ 29,018,000
Supervision and Administration (S&A)		$ 68,973,000
Project Monitoring		$ 6,685,000
Conditionally Authorized Cost	SUBTOTAL	**$ 864,065,000**
Science & Technology Program Cost (10 year Program)		**$ 100,000,000**
Demonstration Program Cost (10 year Program)*		**$ 100,000,000**
Beneficial Use of Dredged Material Program*		**$ 100,000,000**
Investigations of Modifications of Existing Structures		**$ 10,000,000**
Total Authorized LCA Plan Cost		**$ 1,174,065,000**
Multi-purpose operation of Houma Navigation Canal (HNC) Lock [#]		$ -
Terrebonne Basin Barrier shoreline restoration		$ 84,850,000
Maintain Land Bridge between Caillou Lake and Gulf of Mexico		$ 41,000,000
Small diversion at Convent / Blind River.		$ 28,564,000
Increase Amite River Diversion Canal influence by gapping banks		$ 2,855,000
Medium diversion at White's Ditch		$ 35,200,000
Stabilize Gulf shoreline at Point Au Fer Island		$ 32,000,000
Convey Atchafalaya River Water to Northern Terrebonne marshes		$ 132,200,000
Modification of Caernarvon diversion		$ 1,800,000
Modification of Davis Pond diversion		$ 1,800,000
	SUBTOTAL	$ 360,269,000
LERRD		$ 208,100,000
First Cost	SUBTOTAL	$ 568,369,000
Feasibility Level Decision Documents		$ 47,529,000
Preconstruction, Engineering, and Design (PED)		$ 36,027,000
Engineering & Design (E&D)		$ 45,635,000
Supervision & Administration (S&A)		$ 58,673,000
Project Monitoring		$ 5,683,000
Approved Projects Requiring Future Congressional Authorization for Construction		**$ 761,916,000**
Mississippi River Hydrodynamic Study		$ 10,250,000
Mississippi River Delta Management Study		$ 15,350,000
Third Delta Study		$ 15,290,000
Chenier Plain Freshwater and Sediment Management and Allocation Reassessment Study		$ 12,000,000
Acadiana Bays Estuarine Restoration Feasibility Study		$ 7,110,000
Upper Atchafalaya Basin Study^		$ -
Large-scale and Long Term Studies Cost	SUBTOTAL	**$ 60,000,000**
Total LCA Restoration Plan Cost		**$ 1,995,981,000**

*Program total costs include any estimated Real Estate costs for these activities
[#] Feature of the Mississippi River and Tributaries, Morganza Louisiana to the Gulf of Mexico Hurricane Protection project
^ Study to be funded under the Mississippi River and Tributaries authority

2.10 PLAN MANAGEMENT

The purpose of the LCA Management Plan (Management Plan) is to maximize attainment of the planning objectives for restoration of Louisiana's coastal wetlands. This management plan and structure describe how various entities would be integrated into the planning and decision-making process during the LCA Plan implementation. This proposed management structure would also facilitate communication and coordination between the Federal and state agencies in the implementation of broader coastal restoration efforts and programs.

This section of the report describes the working relationships between the various entities and their respective roles and responsibilities to facilitate efficient management of coastal restoration activities. Due to the significance and magnitude of wetlands losses and the far-reaching national extent of the problems generated by coastal Louisiana land losses over the next 50 years, a Washington-level Task Force is needed to fully address the issues.

For each of the groups involved in the implementation of the LCA Program (**figure 2-20**), the purpose, structure, and roles and responsibilities are described. The groups include: Headquarters, a Program Management Team, a Program Execution Team, a proposed Task Force, the Assistant Secretary, a Regional Working Group, and a S&T Office. **Figure 2-20** depicts their overall relationship and the interaction that would be needed to achieve coastal restoration and consistency.

Management of the LCA restoration efforts would also include a decision support system that relies on clearly defined procedures to assess uncertainties and develop alternatives for the decision making process. The decision support system would be developed with and implemented by the program teams, and outputs from the system would be reported to the Program Management Team, who would be responsible for program-level decisions. The decision support system would be developed to explicitly identify constraints and tradeoffs among new projects, existing and backlogged projects and other planning and regulatory decisions made that affect the implementation and effectiveness of restoration efforts. Program planning efforts would support informed decision making in recognition of the interdependencies among actions and the tradeoffs in outcomes affecting the recreational and commercial uses of the working coast.

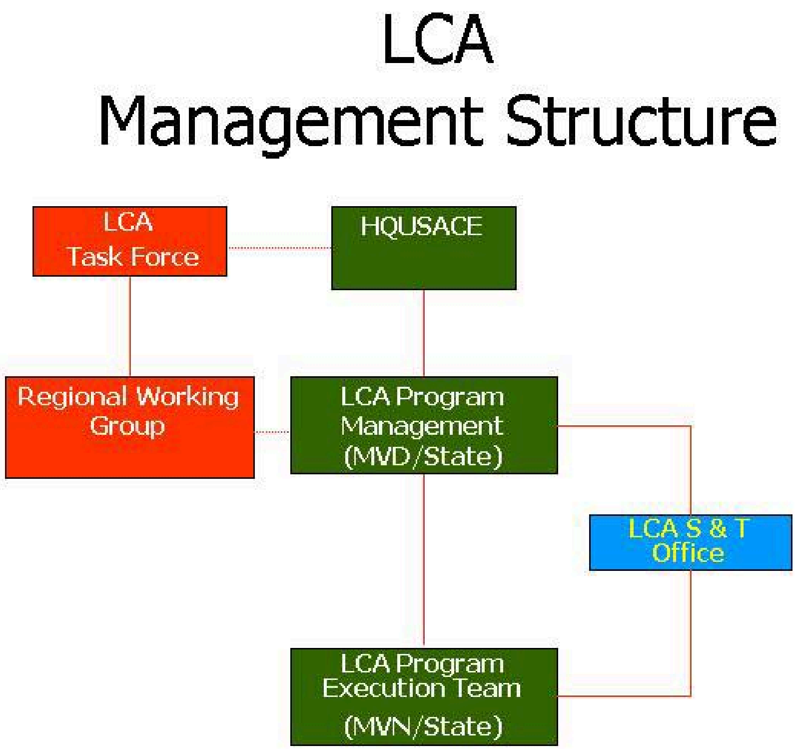

Figure 2-20. Coastal Restoration Management Structure.

2.11 ADAPTIVE ENVIRONMENTAL ASSESSMENT AND MANAGEMENT (AEAM)

As detailed in section 2.2 EXISTING AND FUTURE WITHOUT-PROJECT CONDITIONS, large coastal ecosystems like the Louisiana coastal area are dynamic systems that integrate terrestrial and marine processes nested in scale from global to local influences against a backdrop of historical conditions. The scientific and technological uncertainties outlined in section 3.1 PLANNING CONSTRAINTS, as well as watershed influences that affect delivery of water, sediment, and nutrients, and uncertainty in the timing and magnitude of infrequent, but high-energy events such as floods and storms, storms make response prediction within these large ecosystems inherently difficult. Integration of an AEAM system within the LCA Program would facilitate management of this complex system to best meet the planning objectives.

AEAM prescribes a management process wherein future actions can be changed as the efficacy of past actions on the ecosystem is determined through monitoring and other means to improve knowledge about the response of the system (Holling and Gunderson 2002). The AEAM approach recognizes that uncertainty is unavoidable in managing large-scale ecological systems. If properly planned and maintained, the feedback element can be used to sequentially improve management actions so that future system conditions become more consistent with program goals and objectives than past actions. AEAM allows development of an iterative and flexible approach to management and decision-making.

All organizations within the LCA Management Structure have a role in implementing AEAM. The LCA S&T Office would make AEAM recommendations to the Program Management Team and the PET based on assessment of monitoring data and the development of new tools or technologies. Specifically, the Program Manager is responsible for the overall program and issuing programmatic guidance to make necessary adjustments to better meet program objectives. The PET would implement changes directed by the programmatic guidance. **Figure 2-21** depicts this iterative process and the roles of the different groups.

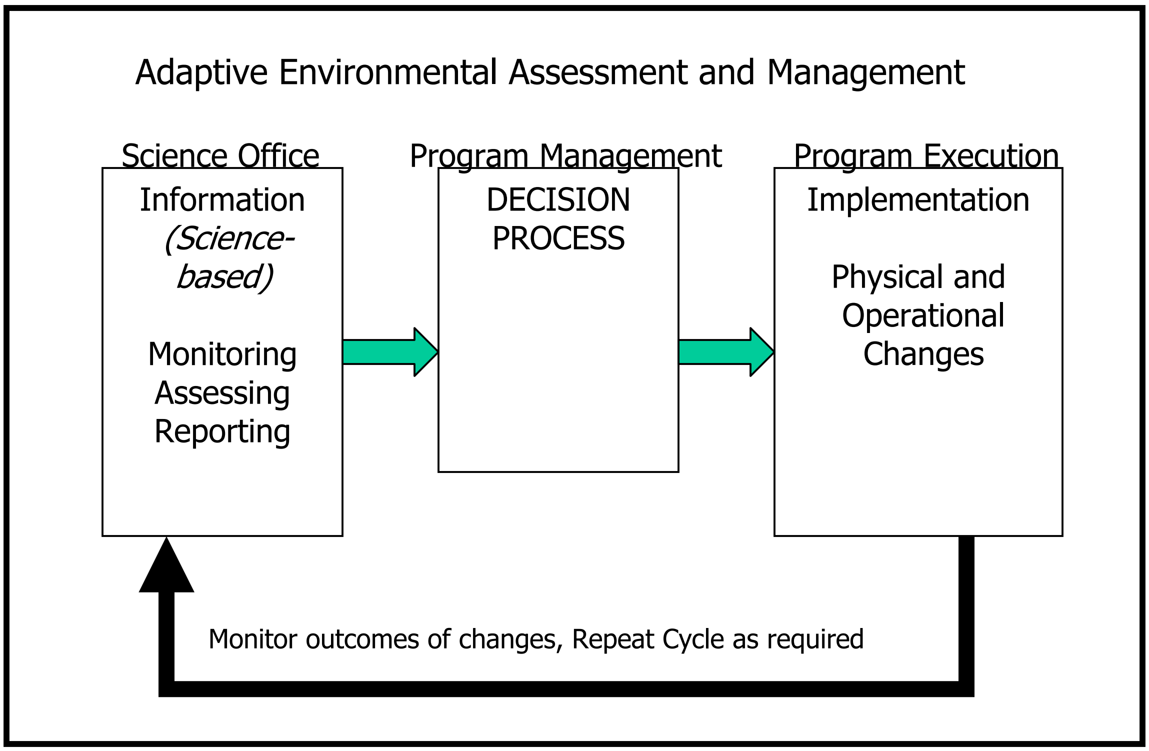

Figure 2-21. Adaptive Environmental Assessment and Management.

It is important to note that the scope of decisions presented in the "decision process" in **figure 2-21** would differ in scale. One way of expressing this is to distinguish between strategic decisions and tactical decisions. Strategic decisions comprise the decisions about the nature and timing of large projects and major policies related to the overall programmatic effort. Tactical decisions comprise those decisions about implementation and operation that are necessary for the projects and policies to succeed. The AEAM framework applies to both strategic and tactical decisions about coastal restoration. The key attribute of the decision process under AEAM is well-defined and effective communication. The AEAM within the LCA Program management would build upon lessons learned over the past several years in CWPPRA, along with CWPPRA-initiated tool development, such as the Coast-wide Reference Monitoring System (Steyer et al. 2003).

The structures and general process outlined in the LCA S&T Program provide the basic elements of an AEAM program. To make the AEAM effort most effective, it would be important to view the restoration effort as a learning process, with adaptation as required. Timely and effective communication of information to all participants would be instrumental in effectively implementing the AEAM process and to further attain program objectives. Examples of communication tools are project-specific assessment reports (report cards), annual programmatic AEAM report, and science symposia convened on an annual or biennial basis. Appendix A SCIENCE AND TECHNOLOGY PROGRAM expands on this general discussion of AEAM.

2.12 COMPARISON OF RESTORATION OPPORTUNITES

2.12.1 No Action Alternative ─ Future Without-Project

The No Action Alternative or future without-project assumes no further ecosystem restoration actions beyond the presently planned/approved construction or maintenance actions in the study area, including those contained in the CWPPRA, and other flood control, navigation, and restoration programs described in Section 1.7 "Opportunities" of this DPEIS and Section 1 "Introduction" of the Main Report.

Without action, marine influences and other natural and human factors, such as subsidence, sea level change, navigation channels, and oil and gas canals would result in continued coastal habitat loss in both the Deltaic and Chenier Plains. Land building would continue in the Deltaic Plain at the two active deltas, as well as in areas influenced by CWPPRA projects and the Davis Pond and Caernarvon Freshwater Diversion Projects. Coastal habitats in these areas of land creation would primarily be freshwater marsh, a result of the riverine influence that formed them. Other areas in the Deltaic and Chenier Plains would experience significant land loss. Louisiana coastal wetlands have been subjected to high rates of relative sea level change (rise) for centuries at least due to high subsidence rates associated with the compaction and dewatering of deltaic sediments. Some Louisiana marshes have adjusted to these high rates, and still survive in areas where measured rates from tide gauges are over 1 cm per year, and others are experiencing stress which may in part be driven by the relative sea level change. In Louisiana it is well documented that high water events associated with frontal passages and tropical storms and hurricanes deliver most of the sediment that is currently deposited in coastal marshes (Reed, 1989; Cahoon et al., 1995). These factors undoubtedly contribute to sustainability of existing Louisiana marshes and it is not known how marshes will accommodate future increases in relative sea level. Quantification of future land loss is described in section 1.5.2.6, PROJECTED 2000-2050 LAND CHANGE SUMMARY.

The preliminary modeling output predicted habitat changes in acres resulting from future without-project conditions. These changes were due to land lost or gained and habitat change due to future conversion between habitat types. Overall there would be a net loss of 13 percent of today's wetland acres. In **table 2-31**, the percent acreage of each habitat type for existing (Year 0) and future without-project (No Action at Year 50) conditions is displayed. In addition, for each subprovince, graphs depict the change in habitat acreage and vegetative productivity index for Year 0, 10, 20, 30, 40, and 50, assuming there is no additional action (**figures 2-21** to **2-24**).

These figures illustrate that decreases in plant productivity across the entire coast are a function of land loss and mirror the continued trend of coastal land loss throughout the study area (see appendix C for more information on plant productivity modeling and calculations).

Table 2-31. Percent Habitat Composition.
With the Future Without-Project Conditions (No Action Alternative) At Year 0 and Year 50 By Subprovince.

Percent Composition							
	Fresh Marsh	**Intermediate Marsh**	**Brackish Marsh**	**Saline Marsh**	**Swamp**	**Water**	**Upland[1]**
Subprovince 1							
No Action Year 0	2.0	4.4	5.0	3.1	9.7	61.8	14.0
No Action Year 50	5.7	2.7	3.9	1.5	9.0	63.2	14.0
Percent Change	185.0	-38.6	-22.0	-51.6	-7.2	2.3	0.0
Subprovince 2							
No Action Year 0	10.1	4.8	3.6	6.6	16.4	40.4	18.1
No Action Year 50	14.2	2.9	0.0	0.0	15.9	48.9	18.1
Percent Change	40.6	-39.6	-100.0	-100.0	-3.0	21.0	0.0
Subprovince 3							
No Action Year 0	12.6	7.1	7.4	4.2	14.3	44.4	10.0
No Action Year 50	1.2	22.8	1.5	0.2	12.4	51.9	10.0
Percent Change	-90.5	221.1	-79.7	-95.2	-13.3	16.9	0.0
Subprovince 4							
No Action Year 0	25.4	20.8	10.1	2.2	0.3	29.8	11.5
No Action Year 50	22.9	17.4	14.8	0.0	0.2	33.2	11.5
Percent Change	-9.8	-16.3	46.5	-100.0	-33.3	11.4	0.0

[1]Approximate percent composition is provided for upland habitat but uplands were not assessed in the coastal land loss modeling effort, as described in appendix B.
Note: The "Percent Change" represents the change for each specific habitat class in each subprovince from Year 0 to Year 50 with No Action. Future without-project conditions were generated from the ecological modeling efforts described in appendix C HYDRODYNAMIC AND ECOLOGICAL MODELING.

Subprovince 1

Over 5 percent of the total emergent wetland acres are predicted to be lost by 2050. Land acreage would continue to decrease through year 2050, while plant productivity, which is based on a percent of maximum productivity as influenced by changes in salinity and inundation, would initially increase through year 10, and then decrease slightly through year 2050 (**figure 2-22**). The majority of the direct wetland loss is expected to be caused by shoreline erosion in the brackish and saline Biloxi Marshes. Cypress swamp could be lost to the west of Lake Maurepas.

Fresh marsh is expected to nearly triple in acreage, especially in the upper Breton Sound marshes where influence of the Caernarvon Diversion would be felt. The predicted approximately 40 percent loss in intermediate marsh is mainly because it is expected to convert to fresh marsh in the Caernarvon influence area. Much of the predicted loss of 20 percent of the existing brackish marsh would be due to conversion to intermediate marsh. By 2050, fresh marsh and swamp/wetland forest are predicted to make up 65 % of the wetlands, and saline marsh only 7 percent.

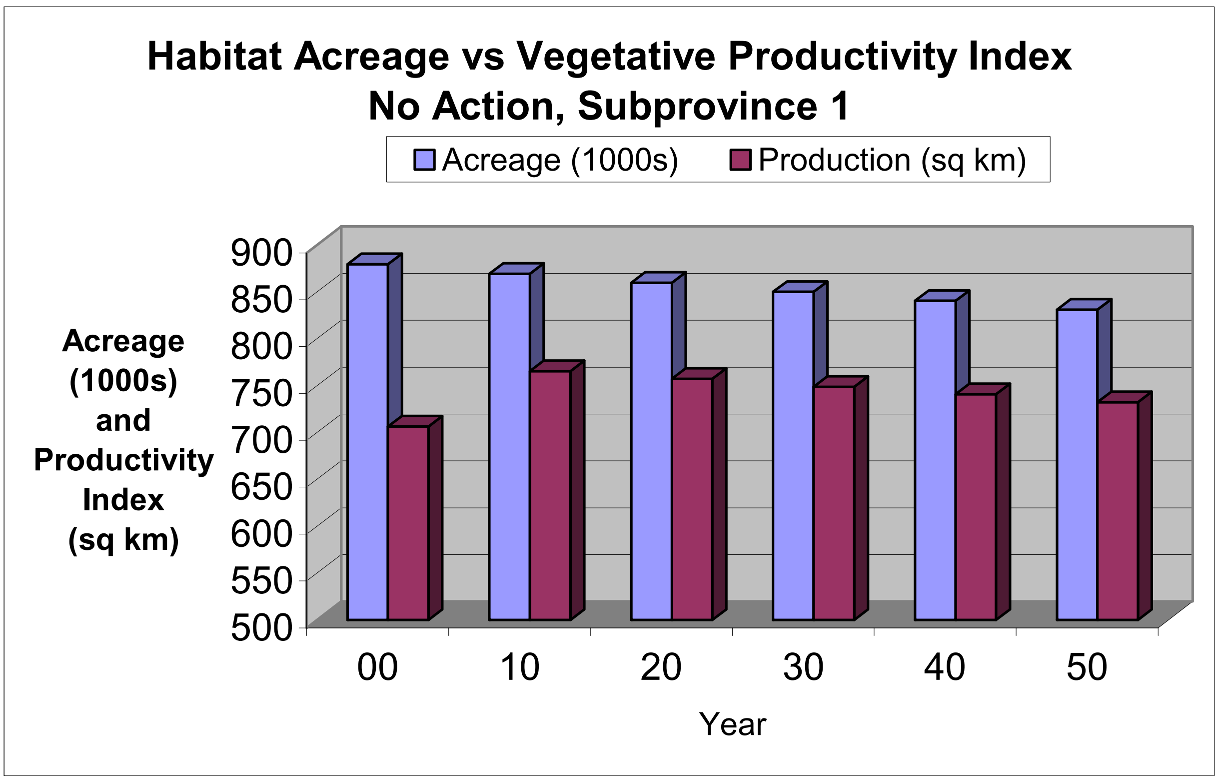

Figure 2-22. Habitat Acreage and Vegetative Productivity Index for Subprovince 1 Under Future Without-Project Conditions.

Subprovince 2

Approximately 22 percent of the existing emergent wetlands are predicted to be lost by 2050. Land acreage would continue to decrease through year 2050, while plant productivity, which is based on a percent of maximum productivity as influenced by changes in salinity and inundation, would initially increase through year 10, and then decrease through year 2050 (**figure 2-23**). The majority of the wetland loss is expected to occur in the lower portions of the subprovince, as existing brackish and saline marshes convert to open water. Losses are also predicted in the upper area in cypress swamp.

Anticipated inputs from the Davis Pond Diversion are predicted to greatly expand the area of fresh marsh by causing the conversion of existing brackish and intermediate marshes to fresh marsh. The total loss of saline marshes is predicted to be mainly due to conversion to open water. However, some saline marsh is expected to convert to intermediate and brackish marsh. By 2050, over 90 percent of the subprovince is anticipated to be fresh marsh and swamp/wetland forest with the remaining 9 percent either intermediate or brackish marsh.

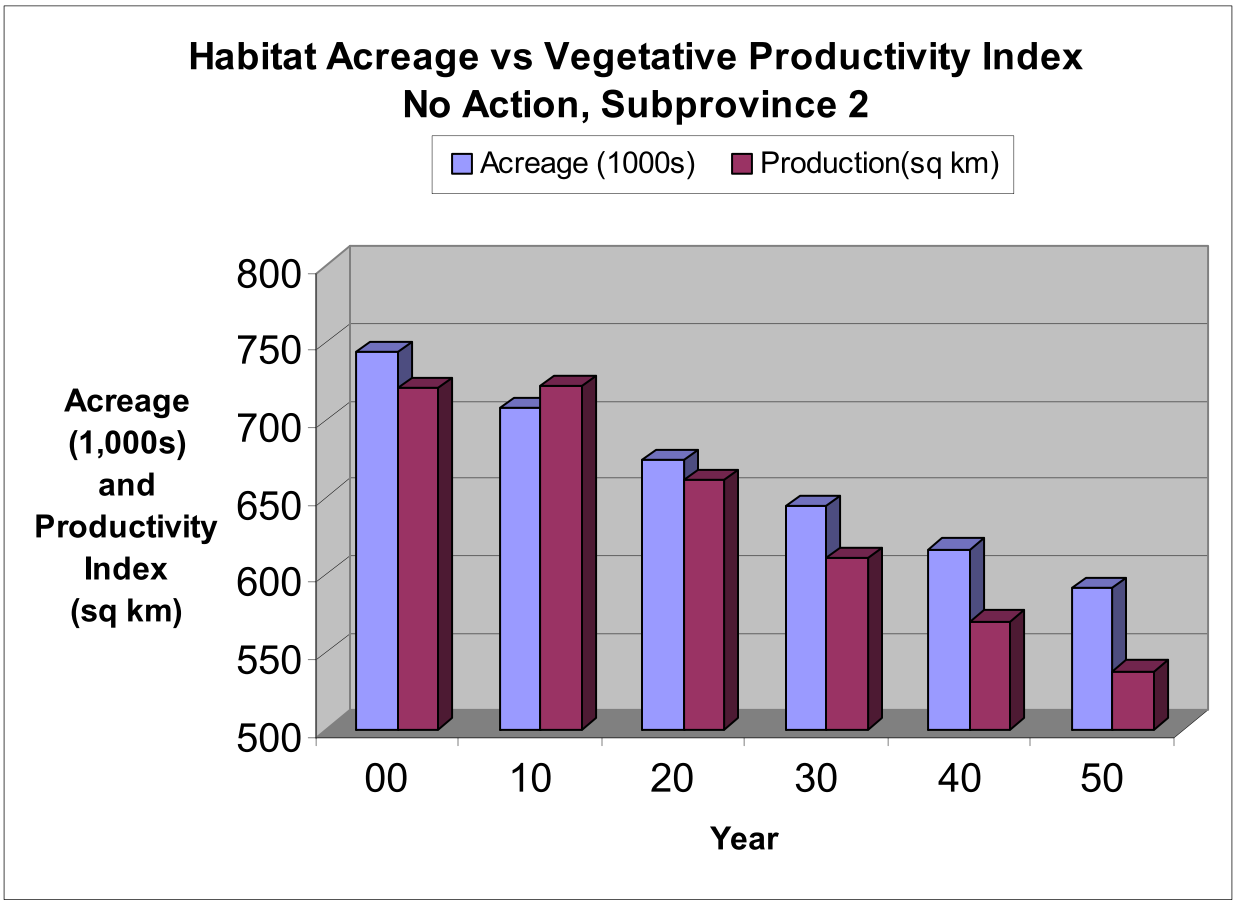

Figure 2- 23. Habitat Acreage and Vegetative Productivity Index for Subprovince 2 Under Future Without-Project Conditions.

Subprovince 3

Approximately 16 percent of the existing emergent wetlands are predicted to be lost by 2050. Land acreage and plant productivity, which is based on a percent of maximum productivity as influenced by changes in salinity and inundation, would continue to decrease through year 2050 (**figure 2-24**). The majority of the loss would occur in the eastern portion of the subprovince with loss increasing from north to south. Additional loss is also predicted north of the GIWW. Whereas land gain is anticipated in the two deltas in Atchafalaya Bay.

Approximately 13 percent of the swamps are predicted to be lost, mainly due to elevated water levels in the Verret Basin. A large increase (220 percent) in intermediate marsh is predicted by the model. This increase is probably due to threshold constraints of the model and the necessity of averaging salinities from western Terrebonne with Atchafalaya Bay. Most of the predicted decrease in fresh marsh is due to conversion to intermediate marsh. The 80 percent decrease in brackish marsh is expected to be caused by conversion to other marsh types and loss to open water. Most of the predicted 95 percent loss of salt marsh would occur as it becomes open water. By 2050, almost 60 percent of the emergent wetlands are predicted to be intermediate marsh, and 33 percent will be swamp and wetland forest.

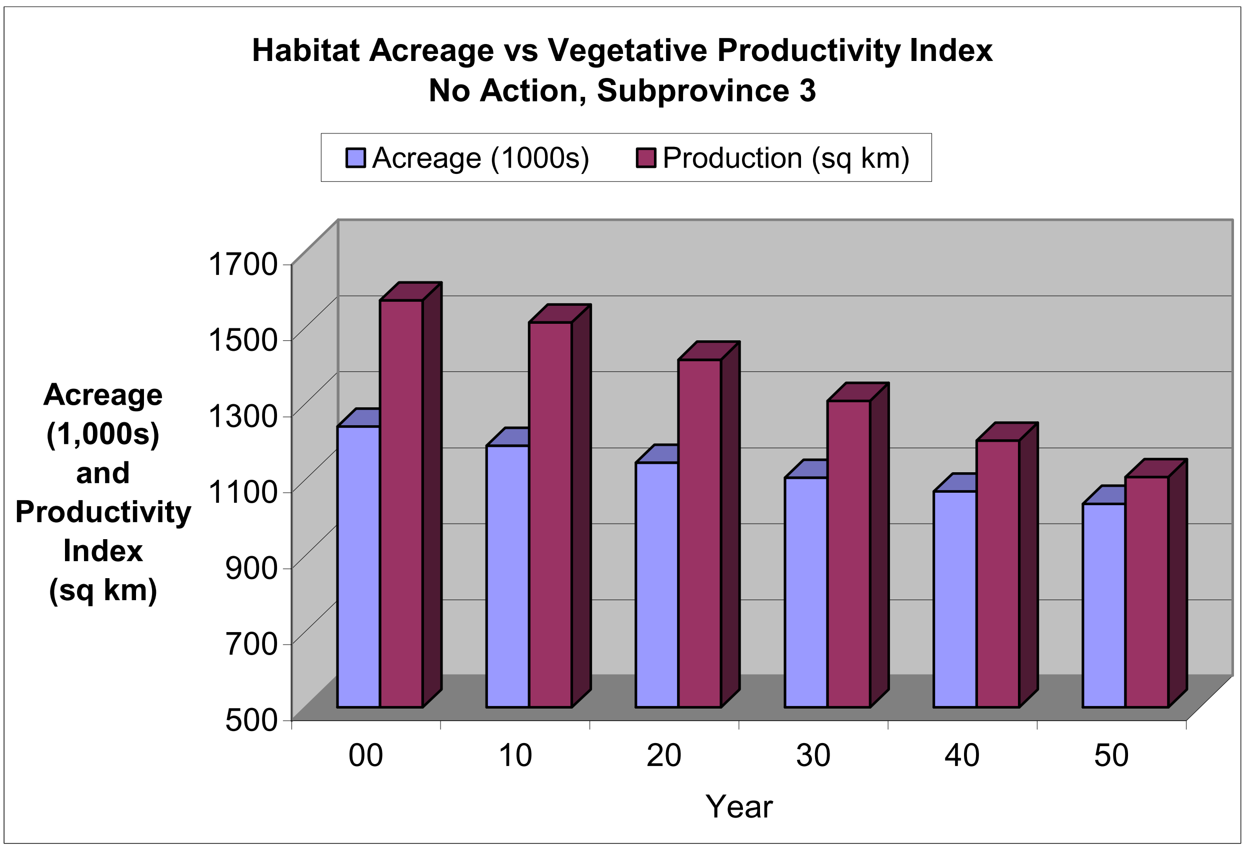

Figure 2- 24. Habitat Acreage and Vegetative Productivity Index for Subprovince 3 Under Future Without-Project Conditions.

Subprovince 4

Approximately 6 percent of the existing emergent wetlands are predicted to be lost by 2050. Land acreage would continue to decrease through year 2050. While a slight increase in vegetation productivity of 3% would occur in the first ten years, a slight declining trend is predicted to follow resulting in a net decrease of 2.4% by year 2050 (**figure 2-25**). Much of the loss is anticipated to occur south of Highway 82 and in the Big Burn area.

Brackish marsh is predicted to expand by almost 150 percent of the current acreage. This increase will be almost entirely because increasing salinity causes conversion of fresh and intermediate marshes to brackish marsh. By 2050, 41 percent of the wetlands will be fresh marsh, 32 percent intermediate marsh and 27 percent brackish marsh.

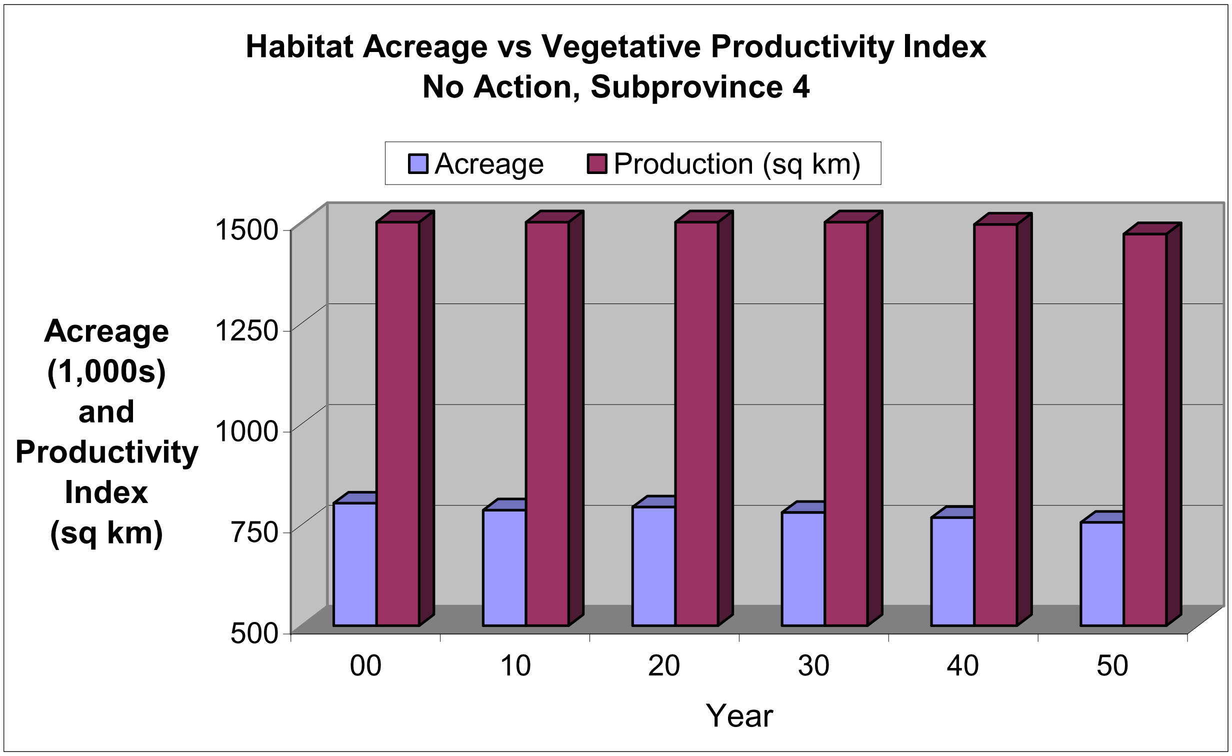

Figure 2-25. Habitat Acreage and Vegetative Productivity Index for Subprovince 4 Under Future Without-Project Conditions.

Table 2-32 is a comparison of the potential impacts of each restoration feature to significant resources.

TABLE 2-32
Comparison of Restoration Opportunities to No Action Among Significant Resources

Significant Resource	No Action	Alternative Plan B (deltaic processes)	Alternative Plan D (geomorphic structure)	TSP
Soils	Continued coastal land loss with predicted 328,000 acres lost over next 50 years; organic soils will not be able to maintain their elevation.	River diversions would build and/or nourish land; dedicated dredging would build new land; hydrologic restoration improves conditions for plant growth resulting in reduction of soil erosion.	Marsh creation would build new land; hydrologic restoration improves conditions for plant growth resulting in reduction of soil erosion.	Impacts would be combination of both ALT B and ALT D.
Offshore Sand Resources	Natural processes continue to build offshore sand deposits; continued multiple uses of offshore sands and sand bodies.	ALT B does not present any likely restoration opportunities for use of offshore sand resources.	Almost all of ALT D restoration features could potentially impact offshore sand resources; there would be short-term minor to long-term significant adverse impacts due to removal of over 61 million cy of sands required for restoration purposes.	Impacts similar to ALT D.
Salinity Regimes	Preliminary modeling shows freshening in influence areas of existing diversions (Subprovince 1&2). However, some increased salinity intrusion into some interior portions of all subprovinces due to human-induced and natural coastal land loss.	Long-term minor direct to long-term minor-to-moderate indirect impacts associated with slight freshening from diversions in localized areas of subprovince 1, 2 and 3; otherwise, salinity regimes would be similar to the future without conditions.	Impacts would be similar to ALT B but to a much lesser degree.	Impacts would be a combination of ALT B and ALT D.
Barrier Systems	Continued natural and human-induced land-loss processes at rates similar to present.	No direct or indirect impacts to barrier systems.	Long-term significant positive impacts of restoring over 32 miles of barrier systems; short-term minor adverse impacts due to construction of restoration features.	Impacts would be a synergistic combination of ALT B and ALT D.
Barrier Reefs	Natural and human-induced processes continue form/erode barrier reefs.	No restoration features for barrier reefs.	No restoration features for barrier reefs.	No restoration features for barrier reefs.
Coastal Vegetation	Long-term significant coast wide net decrease due to continued coastal land losses.	Long-term significant net decrease of all coastal wetland vegetation habitat types, but with a minor reduction in the rate of loss, particularly with small increase in productivity of fresh and intermediate marsh and swamp/wetland forest; brackish and saline marsh and barrier shoreline vegetation would remain similar to the future without conditions.	Long-term significant net decrease of all coastal wetland vegetative habitat types (depending upon the locations of beneficial use), but with a minor reduction in the rate of loss, particularly with brackish, saline and barrier shoreline vegetation.	Impacts would be somewhat greater than the combination of both ALT B and ALT D. Long-term significant net decrease of all coastal wetland vegetation habitat types would occur, but with a small reduction in the rate of loss, and small increases in productivity in all habitat types.
Wildlife	Continued decline in most coastal Louisiana wildlife species.	Most coastal Louisiana wildlife species would benefit.	Most coastal Louisiana wildlife species would benefit.	Impacts would be a combination of ALT B and ALT D.

TABLE 2-32
Comparison of Restoration Opportunities to No Action Among Significant Resources

Significant Resource	No Action	Alternative Plan B (deltaic processes)	Alternative Plan D (geomorphic structure)	TSP
Plankton	Increased potential for algal blooms due to increases in nutrients.	In the Delta Plain, freshwater diversions result in species switching from saltwater-dominant to freshwater dominant.	Restoration of geomorphic structure only would result in negligible impacts.	Impacts similar to ALT B.
Benthic	Increases in benthic species and community diversity.	In the Delta Plain, freshwater diversions result in species switching from saltwater-dominant to freshwater dominant; creation of significant acres of new habitat with greater heterogeneity and interspersion.	Unavoidable direct loss of benthos due to construction activities; however, creation of significant acres of new habitat with greater heterogeneity and interspersion.	Impacts would be a combination of both ALT B and ALT D.
Marine Fisheries	Would have a net loss in fisheries population size and diversity.	Long-term benefits may overcome adverse impacts of increased freshwater input.	Some adverse impacts, with long-term benefits.	Marine fisheries would benefit from this plan
Estuarine-Dependent Fisheries	Would have a net loss in fisheries population size and diversity.	Estuarine-dependent fisheries would benefit due to preservation of habitat.	Estuarine-dependent fisheries would benefit due to preservation of habitat.	Estuarine-dependent fisheries would benefit due to preservation of habitat.
Freshwater Fisheries	Would have a net loss in fisheries population size and diversity.	This plan would benefit freshwater fisheries.	Minimal, if any adverse impacts; some long-term benefits of marsh creation.	Combination of ALT B and ALT D.
Essential Fish Habitat	Continued loss and degradation of EFH.	This plan would preserve some highly productive categories of EFH expected to be lost with no action	This plan would preserve some highly productive categories of EFH expected to be lost with no action in isolated areas of the Louisiana coastal area. This preservation is not expected to be sustainable.	Of the near term plans, this plan best preserves some highly productive categories of EFH expected to be lost with no action.
Threatened & Endangered Species	Continued population decline and loss of critical habitat principally for the piping plover and sea turtles.	Would generally increase and enhance all coastal wetland habitats.	Would increase and enhance piping plover critical habitat (barrier islands) and would generally enhance all habitats.	Would increase and enhance piping plover critical habitat (barrier islands) and would generally enhance all habitats.
Hydrology Flow Patterns	Flow rates would continue to increase.	Increase freshwater flow to the wetlands, Subprovinces 1-3, decrease Mississippi River flow. Effects on water levels not known.	Reduce Gulf flow and alter flow patterns.	Increase freshwater flow to the wetlands, Subprovinces 1-3, decrease Mississippi River flow. Effects on water levels not known. Reduce Gulf flow and alter flow patterns.
Sediment	Sediment supply does not offset land loss.	Increased sediment deposition in wetlands, Mississippi River, existing channels and canals, and estuarine areas, Subprovinces 1-3. Changed deposition patterns in all Subprovinces.	Decreased sediment output in wetlands and estuarine areas Subprovinces 1-3. Changed depocenter patterns in all Subprovinces.	Decreased sediment output in wetlands and estuarine areas all subprovinces. Changed depocenter patterns in Subprovinces 1-3, Increased sediment deposition in wetlands, Mississippi River, existing channels and canals, and estuarine areas Subprovinces 1-3.

TABLE 2-32
Comparison of Restoration Opportunities to No Action Among Significant Resources

Significant Resource	No Action	Alternative Plan B (deltaic processes)	Alternative Plan D (geomorphic structure)	TSP
Water Use & Supply	Some coastal areas, saltwater intrusion events continue & increase in frequency and magnitude. Result is reduced surface supplies & increased reliance on ground water, which is limited in many coastal areas.	All LCA Study components would generally increase freshwater availability in the receiving areas of the subprovinces and decrease freshwater availability in the Mississippi River.	Negligible effects on water use and supply (freshwater availability).	All LCA Study components would generally increase freshwater availability in the receiving areas of the Subprovinces and decrease freshwater availability in the Mississippi River.
Groundwater	Continued withdrawals.	Unlikely impacts on groundwater.	Unlikely impacts on groundwater.	Unlikely impacts on groundwater.
Water Quality	Continued institutional recognition to restore and protect waterbodies, especially with respect to point sources. Nonpoint sources still unregulated and increasing potential for accidental discharges due to exposed infrastructure because of coastal land loss.	Long-term minor-to-moderate positive/adverse effects (depending upon perceptions of water uses) of introducing river water from diversions into receiving basins; similar to what occurred naturally prior to construction of levees. Sediments introduced into the receiving basins from diversions or from direct placement (dredge material disposal) would add some constituents, but would likely not have unacceptable, adverse impacts.	Sediments introduced into the receiving basins from diversions or from direct placement (dredge material disposal) would add some constituents, but would likely not have unacceptable, adverse impacts.	Impacts of the TSP would be a synergistic positive result over and above the additive combination impacts and benefits of ALT B and ALT D.
Historic & Cultural Resources	Potential loss of resources due to natural and human causes.	Requires project specific cultural resources investigation	Requires project specific cultural resources investigation	Requires project specific cultural resources investigation
Recreation	Potential loss of recreational resource base due to coastal land loss.	ALT B would support and sustain a greater number of freshwater-based recreational opportunities, provide for a more stable freshwater-based recreation economy, and possibly increase the Louisiana recreation industry compared to the future without-project conditions.	ALT D would support and sustain a greater number of saltwater-based recreational opportunities, provide for a more stable saltwater-based recreation economy, and possibly increase the Louisiana recreation industry compared to the future without-project conditions.	Impacts similar to ALT B and ALT D in that the TSP includes restoration features common to both of these restoration opportunities.
Aesthetic	Continued human population growth and development and other human activities have the potential to destroy, enhance, or preserve visual resources.	Impacts of maintaining visually appealing resources systems would further support tourism as one travels Louisiana's Scenic byways and remote areas of visual interest.	Impacts similar to ALT B.	Impacts would be a combination of ALT B and ALT D.

TABLE 2-32
Comparison of Restoration Opportunities to No Action Among Significant Resources

Significant Resource	No Action	Alternative Plan B (deltaic processes)	Alternative Plan D (geomorphic structure)	TSP
Air Quality	Continued decline in air quality as human population growth and development increases and despite legislative attempts to address problems.	Some abatement of air quality since restoration would result in reduction of the rate of loss of vegetated habitats and small increase in productivity of fresh and intermediate marsh and swamp/wetland forest thereby positively impacting air quality via absorption of carbon dioxide and other air pollutants. Short-term minor adverse impacts due to construction activities.	Generally same as ALT B except fewer restoration features would result in less long-term abatement and less short-term negative construction impacts.	Impacts would be similar to ALT B and ALT D since the TSP includes restoration features from both plans.
Noise	Continued noise pollution as human population growth & development, industry, and other human activities continue to increase	Noise typically associated with actual construction activities. All legal requirements for noise abatement would be followed. No significant cumulative impacts anticipated.	Similar, but less than ALT B, since ALT D has fewer restoration features.	Impacts would be a combination of ALT B and ALT D.
HTRW	Continued growth of human population, development, industry, and other activities would further increase HTRW areas of concern within the Louisiana coastal area.	An HTRW Phase I ISA would be performed on a project-by-project basis. Any HTRW identified will be avoided or removed prior to initiation of construction activities.	An HTRW Phase I ISA would be performed on a project-by-project basis. Any HTRW identified will be avoided or removed prior to initiation of construction activities.	An HTRW Phase I ISA would be performed on a project-by-project basis. Any HTRW identified will be avoided or removed prior to initiation of construction activities.
Gulf Hypoxia	Continued nutrient loading into Gulf of Mexico; possible upstream abatement.	Small reduction in nutrient loading from Mississippi River to Gulf of Mexico.	No effect.	Small reduction in nutrient loading from Mississippi River to Gulf of Mexico.
Population	Due to coastal erosion population would shift further inland and to urban and suburban areas.	Population shift would be slower. With implementation subsistence fishermen would potentially relocate to follow fishery species that are affected by the change in salinity levels.	Impacts would be similar to ALT B, but less due to fewer restoration features. There would be no relocation of subsistence fishermen.	Impacts would be similar to ALT B and ALT D.
Infrastructure	Infrastructure nearest to the coast would be exposed to more frequent erosion and damage. Infrastructure would have to be relocated, replaced, and repaired.	ALT B would reduce some erosion and damage.	Similar to ALT B, but less due to fewer restoration features.	Impacts would be similar to ALT B and ALT D.
Socio-Economic and Human Resources	Some industrial employers, petroleum, and seafood would be threatened by coastal land loss and storms, thus causing a loss of associated employment and income. Population would shift further inland and to urban and suburban areas.	ALT B would reduce coastal erosion and protect these assets. Loss of jobs and income due to coastal erosion and storms would be reduced.	Impacts would be similar to ALT B, but less due to fewer restoration features.	Impacts would be similar to ALT B and ALT D.

TABLE 2-32
Comparison of Restoration Opportunities to No Action Among Significant Resources

Significant Resource	No Action	Alternative Plan B (deltaic processes)	Alternative Plan D (geomorphic structure)	TSP
Commercial Fisheries	The fishing industry and its supporting business and activities would experience a decline.	Overall with ALT B the industry would be more stable. ALT B could cause a shift from some saltwater species to brackish species. The diversions could increase costs to get to marine waters, though sustainability of the resource is enhanced. The diversion could have a positive impact on the crawfish industry.	ALT D would not impact the industry as much as ALT B.	Impacts would be similar to ALT B and ALT D.
Oyster Leases	Gradual loss of production from leases. Increased production in bands of intermediate distance from freshwater introduction.	SP1-2 reduced production from leases; SP3 slight impacts both negative and positive; no oyster leases in SP4	SP1-3 minimal localized impacts in construction areas; no oyster leases in SP4.	Impacts similar to ALT B and ALT D.
Oil, Gas & Minerals	Increased damages to refineries, wells, and other oil and gas producing facilities and equipment. Some relocations would occur due to erosion.	ALT B would reduce damages and provide protection to these assets.	Similar to ALT B, but would provide some increased protection to the LOOP facility due to restoration of the Caminada-Moreau Headland.	Impacts similar to ALT B and ALT D.
Navigation	Probable damages to and relocation of port facilities, inland waterways, and traffic.	Possible negative impacts due to increased O&M dredging requirements. Could have positive impacts for GIWW traffic.	Possible negative impacts for O&M funding competing with beneficial use funds. Possible significant negative impacts depending on MRGO restoration measures selected.	Similar impacts to both RO1 and RO2.
Flood Control	Continuing erosion of the coast would cause increased flood damages due to storm surge. Some people would choose to relocate.	ALT B would reduce flood damages and prevent some relocations.	Impacts would be similar to ALT B, but less due to fewer restoration features.	Impacts similar to ALT B and ALT D.
Pipelines	Increased damages to pipelines and related equipment. Some relocations would occur due to erosion. Potential for environmental damage and disruptions in our energy supply.	ALT B would increase protection of these assets and decrease damages.	Impacts would be similar to ALT B. Barrier islands and shoreline protection can be expected to increase protection for pipelines.	Impacts similar to ALT B and ALT D.
Hurricane Protection Levees	Continuing erosion of the coast would cause increased flood damages to levees due to storm surge and increased maintenance.	ALT B would reduce some of the damage and increased maintenance to levees. Short-term minor impacts to some levees due to construction activities.	ALT D would have minimal impact on the levee system; some storm surge reduction.	Impacts similar to ALT B and ALT D.
Agriculture	Continuing erosion of the coast would cause increased agricultural flood damages due to storm surge and increased salinity levels.	ALT B would benefit agriculture by limiting saltwater intrusion and would prevent the loss of some agricultural land. Some minor loss of land due to the footprint of construction activities.	ALT D would prevent some of the damage to agricultural lands.	Impacts similar to ALT B and ALT D.

TABLE 2-32
Comparison of Restoration Opportunities to No Action Among Significant Resources

Significant Resource	No Action	Alternative Plan B (deltaic processes)	Alternative Plan D (geomorphic structure)	TSP
Forestry	Continued coastal land loss reduces forestry opportunities.	A net decrease in forestry resources although the rate of loss compared to future without-project would be reduced and small increase in productivity of swamp and wetland forest habitat. Project-induced increases in swamp and wetland forests habitat would provide some opportunities for forestry activities.	No impacts on forestry resources by ALT D.	Impacts similar to ALT B and ALT D.
Water Resources	Increased levels of salinity in some of the coastal areas. Potentially businesses could relocate, adversely impacting jobs, income, population, and employment.	ALT B would reduce salinity levels.	ALT D would have negligible effects. Possibly some decrease in salinity in the MRGO area.	Impacts similar to ALT B and ALT D.

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